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HAILSTORMS IN MICHIGAN, 1920–1923

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The amount of damage done by hailstorms is difficult to estimate. Hail may fall on a young and tender growing crop and practically destroy it, but there is no way of determining what the crop would have produced had the hailstorm not occurred.

In recent years insurance against damage to farm crops is becoming quite common. Considerable amounts are paid each year in losses due to hailstorms. A study of the records of such companies perhaps furnishes one of the best means of determining the total extent of damage to farm crops. This method, in connection with reports from cooperative observers of the Weather Bureau and responses to special requests sent to postmasters and others in regions where hailstorms have been known to occur, was used in studying hail damage in Michigan during the years 1920 to 1923, inclusive.

The Michigan Mutual Hail Insurance Co., composed of farmers in this State, insures against hail damage to various crops, and the officials of this company were kind enough to give the Weather Bureau office at Lansing access to their records and also aid in estimating the total probable damage in certain storms, including that on farms which were not insured. The method used was to multiply the actual damages paid by a factor representing a ratio between the property insured in a section of county and the total area. This was supplemented by estimates of damage received from the other sources mentioned.

For example, if 5 per cent of the farms in a certain county were insured and the damages paid in a certain storm totaled $100, then the total damage was estimated at $2,000, unless an observer on the field estimated the damages to be much greater or less, when the figures were increased or decreased accordingly.

The method is open to considerable possible error, and yet it indicates in a general way the extent of damage. By this system, out of 601 storms reported in the four years, the total damages was estimated at $2,610,678, or $652,670 per year. By years the records are as follows:

Year	Number of storms	Total damage
1920	175	$689,305
1921	200	1,011,845
1922	120	572,300
1923	106	337,228

July had by far the largest number of storms, and also the greatest amount of damage resulted during this month. During the four years there were 176 storms recorded in July, with a total damage estimated at $1,223,161. August came next, with 110 storms and $737,340 estimated damage. June follows, with 95 storms and $435,733 damage. Next in order are September, May, April, and October. No storms were recorded between November 1 and March 31 in any of the four years.

The distribution of hailstorms over the State each year for the three years combined is shown in Figures 1–8. From these it will be noticed that: (1) Very few hailstorms are recorded north of a line from La e Huron, near Omer, Arenac County, westward to the Lake Michigan shore near Benzonia, in Benzie County, except the middle portion of the upper peninsula. (2) The number of hailstorms along the windward shore of the lower peninsula are remarkably small. (3) The area having the greatst number of storms extends in a southwest-northeast direction in the shape of a fan, with the extreme totals at some distance from Lake Michigan, across which the prevailing wind blows. This proves conclusively that the Lakes are effective agents in preventing the vertical circulation which produces hailstorms and tornadoes. It is interesting that the region of greatest frequency of tornadoes in Michigan is practically coincident with the area of greatest frequency of hailstorms.

The paths of some hailstorms could be traced across two or three counties, but the width is usually not greater than one township. In some cases two or three storms, with parallel paths, evidently occurred about the same time.

A detailed statement of the location, date, and extent of damage of each storm follows:

HAILSTORMS IN MICHIGAN, 1920

April 4.—Light hail reported near Kalamazoo, Kalamazoo County.

April 11.—Light hail reported near Saginaw, Saginaw County.

April 20.—Light hail reported near Iron River, Iron County.

April 22.—Light hail occurred near Bloomingdale, Van Buren County; Allegan and Otsego, Allegan County; Saginaw, Saginaw County; Arbela, Tuscola County; Plainwell, Allegan County; St. Joseph, Berrien County; Hillsdale, Hillsdale County; Lansing, Ingham County; Monroe, Monroe County; Eloise, Wayne County; Luther, Lake County; Benzonia, Benzie County; Grand Rapids, Kent County; Iron Mountain, Iron County. No damage reported at any of these places.

May 5.—Light hail reported near Humboldt, Marquette County.

May 19.—Light hailstorm near Marquette, Marquette County.

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FIG. 1.—Hailstorms in April, 1920–1923, inclusive

FIG. 3.—Hailstorms in June, 1920–1923, inclusive

FIG. 2—Hailstorms in May, 1920–1923, inclusive

FIG. 4.—Hailstorms in July, 1920–1923, inclusive

FIG. 5.—Hailstorms in August, 1920–1923, inclusive

FIG. 6.—Hailstorms in September, 1920–1923, inclusive

FIG. 7.—Hailstorms in October, 1920–1923, inclusive

FIG. 8.—Hailstorms April to October, 1920–1923, inclusive

May 20.—Light hail reported near Humbolt, Marquette County.

June 1.—Light hail reported near Ann Arbor, Washtenaw County.

June 6.—Hailstorm in Almona Township, Van Buren County, with damage totaling about $2,000 Allegan County suffered considerable damage this date, as follows: Orange Township, $3,200; Manlius Township, $13,500; Clyde Township, $6,000; and Ganges Township, $6,000.

June 7.—Light hail reported in Menominee, Menominee County; Marquette, Marquette County. Damage unknown.

June 8.—Damage in Greenbush township, Clinton County, about $800; Marquette, Marquette County; damage not reported.

June 9.—Hailstorm in Geneva Township, Van Buren County; damage, $1,800.

June 10.—Light hail near Ewen, Ontonagon County. Light hailstorms in Washtenaw, Oakland, Calhoun and Van Buren Counties. Damage estimated as follows:

Washtenaw County:	
Freedom Township	$2,200
Northfield Township	2,000
Salem Township	850
Oakland County:	
Lyon Township	3,300
Oakland Township	500
Calhoun County, Convis Township	250
Van Buren County, Paw Paw and Lawrence townships	500

June 14.—Light hail near Arbela, Tuscola County.

June 15.—Light hail near Port Huron, St. Clair County.

June 16.—Hailstorms in second tier of counties from Kalamazoo County eastward to Washtenaw. The damage by townships is estimated as follows:

Kalamazoo County, Wakesma Township	$2,900
Calhoun County:	
Penfield Township	2,750
Convis Township	500
Sheridan Township	3,000
Tekonsha Township	200
Jackson County:	
Parma Township	4,500
Sandstone Township	5,500
Grass Lake Township	700
Leoni Township	28,000
Tompkins Township	1,100
Summit Township	5,500
Washtenaw County:	
Sharon Township	13,500
Lodi Township	520
Freedom Township	1,200
Northfield Township	300

Outside of this tier of counties scattered storms did damage as follows:

Gladwin, County, Sage Township	$800
Genesee County, Thetford Township	400
Oakland County, Lyon Township	4,000

June 23.—Light hail occurred at Escanaba, Delta County; Iron River, Iron County. No damage reported.

June 27.—Light hail reported near Iron River, Iron County.

July 1.—Hail reported near Iron River, Iron County.

July 2.—Rather light hailstorms in Genesee, Lapeer, and Sanilac Counties. Damage in Genesee County, Flint and Clayton Townships, about $3,000; damage in Lapeer County, Lapeer and Burnside Townships. $2,500; damage in Sanilac County, Elk Township, $300,

July 7.—Damage in Clinton County, Olive Township, about $2,000; damage in Macomb County, Washington Township, about $1,750; damage in Ionia County, Berlin Township, about $500; damage in Huron County, Sebawaing Township, about $600.

July 8.—Many hailstorms on this date, especially in the southeastern quarter of the State. The greatest damage occurred in Oakland and Lapeer Counties, but the damage was also heavy in some localities in other counties. A tabulation of estimated damages follows:

Genesee County, Fenton, Clayton, Flint Townships	$1,675
Livingston County, Tyrone Township	2,000
Macomb County, Clinton Township	3,000
Oakland County, Orion, Novi Townships	35,000
Jackson County, Watertown, Waterloo, Leoni, Blackman Townships	4,725
Lapeer County, Elba, Almont, Hadley, Metemora, Dryden Townships	32,000
Saginaw County, Tittabawassee Township	1,000
Calhoun County, Eckford, Fredonia, Morengo, Newton Townships	6,500
Branch County, Quincy, Butler, Coldwater Townships	5,875
Ionia County, Portland, Berlin Townships	6,000
Eaton County, Windsor, Chester Townships	1,200
Huron County, Paris Township	500
Washtenaw County, Sheron Township	2,700
St. Clair County, Berlin Township	3,600
Wayne County, Northville Township	2,250

July 11.—Light storm in Antwerp Township, Van Buren County; damage about $500.

July 12.—Grand Marais, Alger County; damage not reported.

July 16.—Considerable damage in Oakland and Wayne Counties. In Oakland County, Bloomfield and Novi Townships, the damage, mostly in latter, totaled about $25,000. Considerable damage in Wayne County, Plymouth Township; damage about $15,000. Slight damage also De Witt Township, Clinton County; about $250.

July 17.—Hail reported at Grand Haven, Ottawa County.

July 18.—Damage in St. Clair County, Emmett and Berlin Townships; about $1,900. Damage in Sanilac County, Marlette and Burnsides Townships, about $23,500. This was mostly in Marlette Township, the following sections being affected: 1, 2, 3, 4, 5, 6, 11, 33, 34, 35, 36. Damage in Macomb County, Richmond and Armada Townships, $16,750; damage in Midland County, Ingersoll Township, $1,500.

July 22.—Slight damage, Washington Township, Macomb County; $500.

July 23.—Light hailstorm at Escanaba Township, Delta County.

July 24.—Light hail reported near Luther, Lake County.

July 27.—Damage, Marlette Township, Sanilac County, about $1,000; damage Freemont Township, Tuscola County, about $350.

July 28.—Light hail occurred near Sault Ste. Marie, Chippewa County.

July 29.—Heavy storm in Ogemaw County, Cummings and Klacking Townships, damage probably exceeded $25,000. Lighter damage Genesee County, Atlas and Grand Blanc Townships; about $1,250; Lapeer County, Hadlay Township, about $850; Van Buren County, Covert Township, about $600.

July 30.—Heavy hailstorm in Hamilton, Clare County, and Sage Township, Gladwin County. These two townships join each other, and the storm swept across the two from west to east. The total damage probably exceeded $15,000, although very definite figures could not be obtained.

August 5.—Light storm, De Witt and Watertown Townships, Clinton County; damage about $1,000.

August 6.—Hail damage occurred over many counties in the southern part of the State. Clinton County suffered a loss probably exceeding $20,000. The heaviest damage in this county was in Dallas Township, where it probably exceeded $7,500. Next in extent of damage

was Water Township, with about $4,000; Lebanon, with $3,500 or more; and the following in the order named, with decreasing amount of damage: Wacousta, Olive, De Witt, Riley, Bengal, Westphalia, Victor, and Essex.

The next county, in amount of damage, was Gratiot, where it probably exceeded $10,000, the following townships, in the order named, suffering most: Fulton, Northshade, Bethany, and Emmerson.

The losses in Ingham County, mostly in Lansing Township, totaled about $9,500, a slight amount of which occurred in Meridian Township.

Genesee County also suffered a loss of about $9,500, in Mundy and Grand Blanc Townships, the damage being slightly greater in the former.

In Macomb County a loss of $2,700 occurred, mostly in Ray and Armada Townships.

The loss in Clare County, mostly Lyon Township, was estimated at $6,000.

In Lapeer County the damage was about $8,500, in Almont and Goodland Townships; mostly the former.

The total damage in Branch County was about $6,000, in Mattison, Sherwood, and Noble Townships, the amounts decreasing in the order named.

In Jackson County a total loss of about $1,600 was divided about equally between Tompkins and Springport Townships.

The damage in Washtenaw County was about $3,300, mostly in Pittsfield township; some also in Scio Township.

In Eaton County, Delta Township, the damage was heavy, probably exceeding $8,000. Light damage also occurred in Eaton and Oneida Townships.

Huron County had a loss of about $10,000, mostly in Sebewaing Township, but the damage was fairly heavy also in Fairhaven and Dwight Townships.

About $6,500 damage resulted in Ionia County, mostly in North Plains Township, with lighter damage in Lyons Township.

In Calhoun County the total loss was probably about $8,000 mostly in Marshall Township; also some in Fredonia and Leroy Townships. Slight damage in St. Clair County, Brockaway, not to exceed $750.

Considerable damage in Gladwin County, Sage Township, probably exceeding $5,000.

Saginaw County, Jonesfield Township, had a loss of about $4,500. Also Ewen, Ontonagon County, reported hail.

August 7.—Damage in Fredonia and Marshall Townships, Calhoun County, about $2,200; Pittsfield Township, Washtenaw County, $350; Columbia Township, Jackson County, $600.

August 8.—Damage, Hamilton Township, Clare County, about $1,750; Fredonia Township, Calhoun County, about $850.

August 9.—Heavy damage occured in several southern counties, including Berrien, Hillsdale, Kalamazoo, and St. Joseph. Lighter damage in several other counties. Damage tabulated as follows:

Berrien County, Oronoca and Benton Townships, about	$20, 000–$25, 000
Kalamazoo County, Texas Townships, about	25, 000–30, 000
Hillsdale County, Woodbridge Township, about	25, 000
Gratiot County, Elba Township, about	6, 000
Ingham County, Delhi Township, about	1, 000
Huron County, Verona, Lincoln, and Sigal Townships, about	2, 250
Eaton County, Welton, Bellvue, Winsor, Potterville, Benton Townships, about	8, 000
Saginaw County, Rockville Township	1, 200
Calhoun County, Fredonia Township	1, 000
St. Joseph County, Sturgis Township	6, 000

August 10.—Storm running from southwest to northeast, starting in Washtenaw, through portions of Livingston, Oakland, Macomb and St. Clair Counties, did considerable damage as follows:

Washtenaw County, Sylvan, Lodi, Lima, Scio Township, about	$3, 000
Livingston County, Handy, Hamburg, Hartland, Putnam Townships, about	17, 000
Oakland County, Commerca, Milford, Bloomfield Townships, about	9, 000
Macomb County, Armada, Bruce Townships, about	2, 000
St. Clair County, Mussey, Lynn, Berlin, Townships, about	4, 000

August 12.—Macomb County, Armada and Bruce Townships, damage about $5,000; Washtenaw County Northfield Township, about $4,000.

August 13.—Oakland County, Waterford Township, damage about $10,000; Ionia County, Boston Township, about $750; Genesee County, Clayton, Gaines, Mundy, Townships, $1,250; Eaton County, Bellevue Township, about $600.

August 14.—Washtenaw County, Dexter and Sylvan Townships, damage $1,250.

August 15.—Ontonagon County, Victoria Township, damage not reported; Marquette County, Ishpeming Township, damage not reported; Luce County, Newberry Township, damage not reported.

August 18.—Washtenaw County, Webster Township, about $400.

August 19.—Berrien County, Creneka Township, damage, $4,000.

August 20.—Washtenaw County, Sylvan Township, damage, $650.

August 27.—Clinton County.— Riley township, damage, $300.

August 28.—Shiawassee County, Burns Township, damage, $1,000.; Livingston County, Howell Township, $1,600.

September 6.—Allegan County, Otsego Township, damage not reported; Lake County, Luther Township, damage not reported.

September 11.—Huron County, Paris township, damage, about $3,500; Huron County, Bigham Township, damage about $500; Mecosta County, Sheridan Township, damage about $1,750.

September 12.—Clare County, Franklin Township, damage about $5,000.

September 26.—Saginaw County, Bloomfield Township, damage about $1, 800; Huron County, Grand Township, damage about $500.

September 28.—Marquette County, Marquette Township, damage not reported.

September 29.—Alger County, Munising Township, damage not reported; Allegan County, Allegan Township, damage not reported.

October 5.—Huron County, Colfax Township, damage about $2,500.

October 10.—Mason County, Ludington Township, damage unknown.

October 11.—Gratiot County, Alma Township, damage not reported; Tuscola County, Arbela Township, damage not reported.

October 13.—Houghton County, Houghton Township.

October 28.—Alger County, Munising Township.

HAILSTORMS IN MICHIGAN, YEAR 1921.

April 9.—Hail was reported in Gratiot County, near Alma; damage not reported.

April 16.—Hailstorms occurred in Allegan County, near Plainwell and Allegan; also in St. Clair County, near Port Huron; Tuscola County, near Arbella.

April 21.—Light hail was reported in Tuscola County, near Arbella; in Genesee County, Thetford and Forest Townships, damage slight, total estimated at $250; Tuscola County, Millington Township, slight damage; Saginaw County, Chesaning and Maple Grove Townships, considerable damage; total in county about $6,750.

April 25.—Light hailstorms occurred in Allegan County, near Allegan and Plainwell, and in Houghton County, near Houghton.

April 28.—Light fall of hail in Gratiot County, near Alma.

April 30.—A hailstorm occurred in Marquette County, Ishpeming.

May 3.—Hail was reported in Chippewa County, near Sault Ste. Marie.

May 13.—Hailstorms occurred in Wayne County, near Detroit, and Luce County, near Newberry.

May 21.—Light hail reported in Eaton County, with about $250 damage in Sunfield Township; also in Marquette County, near Humboldt.

May 22.—Hailstorms occurred in Alpena County, near Alpena; Iosco County, near East Tawas; in Ontonagon County, near Victoria, and in Delta County, near Escanaba.

May 23.—Falls of hail occurred in Allegan County near Allegan, Otsego, and Plainwell; in Saginaw County, near Saginaw; in St. Clair County, near Port Huron, and Iosco County, near East Tawas.

May 24.—Hailstorms occurred in Calhoun, Eaton, Bay, and Saginaw Counties. Damages in Calhoun County, Sheridan Township, about $1,000; Bay County, Frankenmuth Township, estimated damage $2,000; and in Kochville Township, Saginaw County, total damage about $400.

May 25.—Hailstorms occurred in Saginaw County, near Saginaw; Washtenaw County, near Ann Arbor; Kalamazoo County, near Kalamazoo.

May 27.—Heavy hailstorms in Ionia County, especially in North Plains and Sebewa Townships, with estimated losses of $16,500. Hail was heavy also in Sunfield Township, Eaton County, with estimated damage of $3,300. In Branch County, near Coldwater, hail caused damages estimated at $1,250. In Columbia Township Jackson County, the damage was about $775.

May 28.—Light hailstorms were reported in Wayne County, near Detroit; in St. Clair County, near Port Huron.

May 30.—Hail was reported in Delta County, near Escanaba.

June 3.—Light hail was reported in Allegan County, near Ganges.

June 5.—Light hailstorm, Denmark Township, Tuscola County.

June 18.—Hailstorm in Mayfield Township, Lapeer County, with estimated damage of $3,500. In Flint and Clayton Townships, Genesee County, the damage from hail on this date was estimated at $5,300; also in Marquette County, near Ishpeming.

June 20.—Slight damage in Ingham and Van Buren Counties, probably not to exceed $1,250.

June 21.—Damage in Coe Township, Isabella County, about $2,500; in Jasper Township, Midland County, about $4,250; in Homer Township, Calhoun County, about $1,000; near Detroit, Wayne County, unknown.

June 25.—Damage in Saline Township, Washtenaw County, about $350; in Adams Township, Hillsdale County, about $7,500; in Paw Paw Township, Van Buren County, about $6,500; in Bangor Township, Van Buren County, about $7,250.

June 26.—In Windsor Township, Eaton County, damage estimated at $2,825 occurred. In Benton Township, Eaton County, the damage was about $800. In Ingham County, Delhi Township, estimated damage $4,350; in Van Buren County, Antwerp and Paw Paw Townships, the damage was nearly $8,000; in Texas Township, Kalamazoo County, the damage was estimated at $7,000.

July 2.—Slight damage in Texas Township, Kalamazoo County.

July 4.—Heavy hailstorms in Eaton Township, Eaton County, damages about $6,000, and in Eaton Rapids Township, Eaton County, about $1,000.

July 5.—Several severe hailstorms this date. Greatest damage occurred in Genessee County, city of Flint, estimated at $50,000, by the postmaster, Flint, Mich. The width of path of this storm was estimated as 4 miles. The hailstones were one-fourth to one-half inch in diameter. The storm occurred about 4 p. m., and came from the northwest. Outside of Genessee County the next greatest damage on this date was in Paw Paw Township, Van Buren County, estimated at $18,500. In Bloomfield Township, Saginaw County, the damage totaled about $14,000; Meridian Township, Ingham County, suffered about $2,500 from a hailstorm; Crystal Township, Montcalm County, about $2,000; Hartland Township, Livingston County, about $1,000, while lesser damage occurred in sections of Huron and Calhoun Counties, respectively, about $700 and $200. Also in Kent County, near Grand Rapids, damage slight.

July 6.—On this date there were many and scattered hailstorms. The total damage was considerable, but the loss was not great in any one section. The damages might be tabulated as follows:

Gratiot County, Seville and Arcola Townships, about	$2,000
Sanilac County, Maple Valley Township, about	670
Huron County, Sebawaing Township, about	4,750
Lapeer County, Goodland and Dryden Townships, about	1,250
Saginaw County, Frankenmuth and Birch Run Townships, about	2,750
Oakland County, White Oak and Highland Townships, about	3,300
Eaton County, Eaton and Brookfield Townships, about	1,200

Also in Luce County, near Newberry, damage not reported.

July 7.—Heavy hailstorm in Mason County, Sheridan, Sherman, Branch, and Freesoil Townships. "Hailstones size of walnuts; some nearly as large as small hen's egg." Width of path about 2 miles. Total damage must have been more than $25,000. Light hailstorm also near Eaton Rapids, this date; also in Alger County, near Munising.

July 8.—Severe hailstorm in Sunfield and Roxand Townships, Eaton County. Over $50,000 damages estimated in these two townships. The damage was fully as great or even greater also in Woodland Township, Barry County, the three townships lying in a row running east and west. The storm was evidently about 3 miles in width, the path of greatest destruction being about 12 miles long. No report available as to size of hailstones.

In addition to the storm mentioned, damage from hail occurred in several other counties on this date, as follows:

Gratiot County, Bethany Township, about	$1,500
Saginaw County, Bloomfield Township, about	800
Genessee County, Clayton Township, about	4,500
Gladwin County:	
Second Township, about	1,600
Gladwin and Grout Townships, about	1,900
Clare County, Hamilton and Arthur Townships, about	13,500
Sanilac County, Minden Township, about	900
Isabella County, Nottawa Township, about	4,250

July 9.—Tuscola County, Gilford Township, damage about $700.

July 10.—Sanilac County, Lexington Township, damage about $650.

July 13.—Isabella County, about $7,500, heaviest in Nottawa Township; lighter in Fremont, Rolland, Deerfield, Bloomfield, and Isabella Townships. Also in Chippewa County, near Sault Ste. Marie.

July 14.—Scattered hailstorms in the central portion of the State; estimated damage as follows:

Eaton County, Eaton Rapids Township	$4,500
Isabella County, Nottawa, Fremont, Bloomfield Townships	3,800
Branch County, Algansee Township	600
Washtenaw County, Bridgewater Township	650
Livingston County, Putnam Township	3,350
Monroe County, Raisinville Township	1,500

July 15.—Isabella County, Vernon Township, damage about $400. On this date very heavy and destructive hailstorm occurred in the northwestern portion of Saginaw County, in Jonesfield, Richland, Lakefield, and Fremont Townships. The postmaster at Merrill, in Jonesfield Township, reports that the storm was about 3 miles in width and 10 miles in length, extending from north to south. Hailstones were one-half inch in diameter, killing chickens, breaking windows, and destroying farm crops. The storm occurred at about 12:30 p. m. The damage in the vicinity of Merrill he estimates at $60,000 to $75,000. The total damage of the entire storm probably exceeded $100,000 in Saginaw County, while farther north, in Mount Holey and Ingersoll Townships, Midland County, the damage was estimated at $68,500. Lighter storms on the same date occurred in Shiawassee County, Rush Township, damage about $5,000; Sage Township, Gladwin County, about $8,000, and light damage also in Marion Township, Sanilac County.

July 18.—Hailstorm in Webster Township, Washtenaw County; damage about $1,500.

July 26.—Hailstorm in Bloomfield and Sigel Townships, Huron County, with total estimated damage of $3,000. Very light damage reported this date also in Isabella, Clinton, and Sanilac Counties, with damage estimated at from $200 to $650 in individual counties.

July 29.—Widespread hailstorms on this date. Most destructive in Tuscola and St. Clair Counties. In Tuscola County the greatest damage occurred in Denmark, Junista, and Gifford Townships, probably exceeding $15,000 in each township. In St. Clair County the greatest damage was in Casco Township, where the damage was nearly $50,000. Damage elsewhere in the county was estimated as follows: Mussey Township, $3,350; Lynn Township, $3,000; China Township, $2,000; Cotterville Township, $1,500; Emmett Township $2,800; Berlin Township, $1,000; Riley Township, $2,000; Ira Township, $3,600; and Wales Township, $5,250. On the same date, in New Haven Township, Shiawassee County, the damage from hail was about $4,000. In Long Rapids Township, Alpena County, estimated damage $1,500. Slight damage in Clayton and Flushing Townships, Genesee County, probably not exceeding $600. In Burlington Township, Lapeer County, damage about $5,275. Hamilton Township, Clare County, about $6,200; Sage Township, Gladwin County, about $1,350; Lincoln Township, Berrien County, about $16,500; Merritt Township, Bay County, about $1,600. In Richmond Township, Macomb County, the storm was described as "very severe," path about 3½ miles wide; total damage about $9,000.

July 30.—Another date with heavy hailstorms, probably doing more than $100,000 damage in the State as a whole. The county suffering the greatest damage was Clare (Hamilton and Arthur Townships), where the damage was estimated $47,300. Berrien County had a loss of about $25,000 in Royalton and Lake Townships, mostly in the former. The loss in Genesee aggregated about $10,000, in Mundy, Gaines, Flushing, Clayton, and Flint Townships. The loss in St. Clair County, Casco, China, and Columbus Townships, totaled nearly $6,000; while in Gladwin County, Sage, Gladwin, Buckeye, and Lutman Townships, the damage probably exceeded $11,000. In Midland County damage to the extent of $5,250 occurred; also in Calhoun and Livingston Counties this date, probably not exceeding $750 in either county; also in Chippewa County, near Whitfish Point.

July 31.—Light hail in Gladwin County, Nester Township, damage about $750, and Calhoun County, Lee Township, about $200.

August 5.—Light hail occurred in Houghton County, near Houghton.

August 6.—Destructive hailstorm 4 miles north of Port Huron. Stones as large as golf balls. Path about 2 miles long and 2 miles wide, total damage estimated at $25,000; Lapeer County, Townships of Imlay, Elba, Hadley, and Lapeer, damage about $2,500.

August 13.—Moderately heavy hail in Lexington Township, Sanilac County, with damage estimated at $5,000, lighter damage in same county, Elk and Buel Townships, not over $1,600 damage in two. Light storms in Macomb, Ingham, Tuscola, and Shiawassee Counties, the damages in all probably being less than $5,000.

August 17.—Destructive hailstorms in several counties. Greatest damage in Barry County, Woodland Township, and lighter in Castelton and Barry Townships, with total for county near $50,000. In Eaton County the damage was about $17,500, with greatest damage, in order, in townships of Roxand, Oneida, and Sunfield. Washtenaw County suffered a loss of about $16,000, mostly in Webster, Scio, Northfield, and Lima Townships and lighter damage in Dexter, Ann Arbor, Pittsfield, and Sylvan Townships.

August 18.—Hail damage in Woodland Township, Barry County, about $5,000.

August 29.—Slight damage in Clare and Gladwin Counties, about $500 each.

August 30.—Hail damage in Clare County about $25,000. About $17,500 of this was in Hamilton Township. Shiawassee County damage about $1,500, in New Haven and Caledonia Townships, mostly the former.

September 4.—Light hail occurred in Lake County, near Luther.

September 20.—Hailstorms reported in Houghton County, near Houghton.

September 29.—Hail was reported in Iron County, near Iron River; also in Union Township, Isabella County, damage about $7,500.

September 30.—Light hailstorm in Grand Traverse County, near Fife Lake; Benzie County, near Benzonia; Branch County, near Coldwater; and in Alger County, near Munising.

October 2.—Light hail reported in Delta County, near Escanaba.

October 3.—Hailstorms occurred in Allegan County, near Otsego, Trowbridge, and Allegan; in Calhoun County, near Albion; Jackson County, near Jackson; Saginaw County, near Saginaw; Lake County, near Luther; Berrien County, near St. Joseph; Gratiot County, near Alma; Mason County, near Ludington; Shiawassee County, near Durand.

October 4.—Hailstorm was reported in Berrien County, near St. Joseph; also in Mason County, near Ludington.

October 7.—Hailstorms were reported in Mason County, near Ludington; Benzie County, near Frankfort; in Ontonagon County, near Victoria; and in Allegan County, near Munising.

October 8.—There were falls of hail over Berrien County, near St. Joseph; Washtenaw County, near Ann Arbor; Calhoun County near Battle Creek; Huron County, near Harbor Beach; Mason County, near Ludington.

October 12.—Hailstorms were reported in Antrim County, near Old Mission; Calhoun County, near Albion; and Allegan County, near Plainwell and Otsego.

October 17.—A hailstorm was reported in Ottawa County, near Grand Haven.

October 22.—Light hail fell in Allegan County.

HAILSTORMS IN MICHIGAN, 1922

April 3.—Fine hail fell several times near Newberry, Luce County; no damage reported.

April 7.—Hail fell near Sault Ste. Marie, Chippewa County; there was no damage. Also near Omer, Alger County.

April 10.—Hail fell near Plainwell, Allegan County; no damage.

April 11.—Hail was reported near Alma, Gratiot County; Bay City, Bay County; Big Rapids, Mecosta County; Newberry, Luce County. There was no damage as nothing had started to grow.

April 16.—Hail fell near Wellston, Manistee County; no damage.

April 17.—Falls of hail were reported near Alma, Gratiot County; Lansing, Ingham, Newberry, Luce County; and near Harbor Beach, in Huron County. At the latter locality the hail was very large, but the damage was nothing, as there were no growing things started.

April 19.—Hail was reported near Otsego, Allegan County, and also near Plainwell in the same county.

May 4.—Hail fell at Ludington, Mason County, without damage.

May 6.—Hart, Oceana County, also in Huron County, near Ubly were visited by hailstorms; damage about $1,825.

May 16.—Bloomingdale, Van Buren County; also Ironwood, Gogebic County, had falls of hail; there was no damage reported.

May 17.—Victoria, Ontonagon County; no damage.

May 18.—Light hail at Battle Creek, Calhoun County, and at Plainwell, Allegan County; no damage.

May 24.—Clinton County, near St. Johns and Fowler; damage $3,500.

June 5.—Severe hailstorms visited an area bounded by Ionia Shiawassee, Oakland, Livingston, and Ingham Counties, with damage estimated as follows:

Shiawassee, near Shaftsburg	$6,000
Oakland, near Milford	1,200
Ingham, near Haslett and Lansing	1,200
Ionia, near Ionia, Lake Odessa, and Portland	9,500
Livingston, near Fowlerville	2,500

June 8.—Light fall of hail reported from Wayne County, near Eloise.

June 9.—Moderate to heavy falls of hail fell quite generally from Van Buren County northeastward through Huron County, with damage estimated as follows:

Huron County, near Harbor Beach, damage unknown.	
Allegan County, near Fennville and Allegan	$2,900
Eaton County, near Eaton rapids	12,270
Van Buren County, near Paw Paw	500
Ingham County, near Mason	5,500
Calhoun County, near Athens and Ceresco	300
Livingston County, near Fowlerville	300
Genesee County, near Flint and Flushing	5,500
Sanilac County, near Minden City	450
Allegan County, near Allegan, damage unknown.	

June 10.—Shiawassee County, near Durand; damage unknown.

June 11.—Bay county, near Bay City; damage unknown.

June 16.—Severe and even violent thundersqualls accompanied by damaging falls of hail and with heavy downpours occurred from the southwestern corner of the State northeastward through Ogemaw and Sanilac Counties. The damage reported was as follows:

Ionia County, near Pewamo and Lyons	$7,800
Shiawassee County, near Shaftsburg, Henderson, and New Lathrop	7,000
Clinton County, near St. Johns, Westphalia, Eagle, Fowler Elsie, and Merle Beach	3,000
Calhoun County, near Athens, Homer and Tekonsha	2,000
Lenawee County, near Morenci, cloudburst and fall of hail.	
St. Joseph County, near Golen and Sturgis	9,000
Ionia County, near Webber Dam, damage unknown.	
Sanilac County, near Sandusky	2,750
Manistee County, near Wellston, damage unknown.	
Ogemaw County, near West Branch	13,000
Van Buren County, near Hartford, Lawrence and Decatur	4,500

June 17.—Falls of hail were reported in Newaygo County, near Croton, and in Oceana County, near Hart; damage unknown.

June 27.—Light to moderate falls of hail occurred over the central portion of the Lower Peninsula, with damage as follows:

Eaton County, near Eaton Rapids and Charlotte	$1,400
Calhoun County, near Battle Creek	200
Gratiot County, near St. Louis	4,000
Isabella County, near Shepard	2,000
Ingham County, near Mason	7,150
Van Buren County (territory unknown)	1,500

June 28.—There was a heavy fall of hail in Van Buren County, near Lawton and Paw Paw, damage $9,150.

June 30.—Hail fell heavily in Sanilac County, near Sandusky and Deckerville, the damage being estimated at $25,000. A moderate fall in Clinton county, near Elsie, damage $1,700.

July 3.—A heavy hailstorm occurred in Jackson county near Jackson, the damage being estimated at $12,000.

July 7.—A light fall in Ingham, near Williamston, damage $700.

July 8.—Light falls of hail; in Tuscola county, near Vassar, the damage being reckoned as $360; Sanilac County, near Crosswell, $340.

July 9.—A fall of hail occurred in Gogebic County, near Ironwood. No estimation of damage is known.

July 10.—Light falls of hail were reported as follows: Sanilac county, near Sandusky, damage $630; Genesee County, in Grand Blanc Township, $250.

July 15.—A thunderstorm accompanied by hail was reported in Keweenaw County, near Eagle Harbor; damage unknown.

July 16.—Light to heavy fall of hail in Manistee County, damage unknown; also on the same date as follows:

Eaton County, near Dimondale, in Windsor Township	$425
Clinton County, near Dewitt	704
Oceana County, in Elbridge Township	24,050

July 18.—In Kalkaska County, near Ivan; damage not reported.

July 31.—Severe disturbances accompanied by lightning, very large hail, and winds of almost cyclonic force obtained over the southern counties of the lower penin-

sula. In Lenawee County, near Morenci and Adrian, hail as large or larger than hens' eggs fell, doing heavy damage. In many counties the loss in crops was serious. A tornado occurred near Rollin. The damage was estimated as follows:

St. Clair County, Marine City and St. Clair	$1,600
Clinton County, near St. Johns, Merle Beach, Bath, and Fowle	15,000
Genesee County, near Davidson	2,400
Jackson County, near Rives Junction and Grass Lake	19,000
Washtenaw County, near Manchester, Ann Arbor, and Saline	6,500
Lenawee County, near Adrian	20,000
Saginaw County, near Hemlock	600
Shiawassee County, near Owosso	6,500
Wayne County, near Detroit, damage not reported.	

August 2.—Moderate falls of hail, with damage as follows:

Clare County, near Clare	$3,000
Clinton County, near St.Johns	400
Ingham County, near Lansing	1,000
Wayne County, near Detroit, damage unknown.	
Delta County, near Escanaba, damage unknown.	

August 3.—Light to heavy fall of hail occurred over the central counties of the southern lower peninsula, with damage as follows:

Ingham County, near Lansing	$7,500
Arenac County, near Turner	22,500
Oakland County, near Oeford	3,000
Livingston County, near Rushton	10,000
Clinton County, near St. Johns, Dewitt, and Merle Beach	4,800
Washtenaw County, near Whitmore Lake	300
Isabella County, near Rosebush	375
Eaton County, near Vermontville	110
Calhoun County, near Albion	180

Near Albion it hailed for 30 minutes, with stones as large as one-half inch in diameter. Three different storms passed over during the afternoon. Ingham County, near Lansing, hail was reported but damage unknown.

August 7.—Moderate and heavy falls of hail; damage estimated:

Lapeer County, near Clifford	$3,500
Tuscola County, near Reese and Mayville	9,200
Sanilac County, near Marlette and Lexington	10,000
Midland County, near Midland	22,500
Saginaw County, near Saginaw and Hemlock	1,000
Calhoun County, near Albion	250
Washtenaw County, near Ann Arbor	1,200
Jackson County, near Jackson	7,500
Livingston County, near Rushton	1,000

August 17.—Luce County, near Newberry; considerable hail fell the size of large hazelnuts from 4 to 4:15 p. m.; damage unknown.

August 24.—Grand Traverse County, near Fife Lake; damage unknown.

September 1.—Light to very heavy and damaging falls of hail; the extreme south central part of the lower peninsula was visited.

Genesee County, near Clio and Mount Rose	$250
Jackson County, near Springport	5,500
Eaton County, near Eaton Rapids	820
Calhoun County, near Albion	2,000
Hillsdale County, near Osseo	750
Ingham County, near Leslie and Mason	4,500
Cass County, near Marcellus	6,000
Van Buren County, near Mattawan, Paw Paw, Bangor, and Decatur	97,200

September 2.—Wayne County, near Detroit; no damage estimate. Van Buren County, near South Haven; no damage estimate.

September 6.—Sanilac County, Sandusky; damage, $250.

September 7.—Livingston County, near Howell; damage, $3,000.

September 8.—Oceana County, near Hart; no damage.

September 9.—St. Clair County, near Port Huron; light fall of hail without loss.

October 12.—Bay County, near Bay City; damage slight.

October 23.—Saginaw County, Saginaw; damage slight.

HAILSTORMS IN MICHIGAN, 1923

April 21.—Light hail fell near Alma, in Gratiot County, and Albion, in Calhoun County; at the latter place the time was from 2:10 p. m. to 2:25 p. m. There was no damage to crops, as nothing had been planted because of the backward season.

May 10.—Light hail fell near Saranac, Ionia County; no damage reported.

May 12.—There was a hailstorm near Saranac, in Ionia County; no damage reported.

May 19.—Falls of hail occurred at Otsego, Plainwell, and Trowbridge, in Allegan County; no estimate of damage was given. Heavy falls of hail visited several other counties, with damage as follows:

Gratiot County, in Pine River Township	$500
Midland County, in Jasper Township	2,500
Isabella County, in Coe Township	5,250

May 20.—Light hail fell near Saranac, Ionia County; also near Big Rapids, Mecosta County; no damage reported.

June 2.—Light falls of hail fell in Dwight and Lincoln Townships, Huron County, with damage estimated at $670.

June 5.—There were light hailstorms in Bengal Township, Clinton County; damage about $40. Also near Ann Arbor, in Ann Arbor Township, Washtenaw County.

June 6.—Moderate and heavy hailstorms occurred in two counties: Texas Township, in Kalamazoo County; damage $1,000; Raisinville, in Monroe County, damage $8,750.

June 7.—A serious hailstorm swept over Texas Township, Kalamazoo County, damage $8,550; Antwerp Township, in Van Buren County, $750.

June 13.—Very light hailstorm in Westphalia Township, Clinton County; damage $60.

June 14.—Light to moderate falls of hail occurred as follows: Broomfield Township, Isabella County, damage $575; Novi Township, Oakland County, $3,300.

June 20.—Light hailstorm in Watertown, Tuscola County, with damage estimated at $100.

June 21.—Light fall of hail near Fife Lake, in Homes Township, Grand Traverse County; no damage reported. In Gilford Township, Tuscola County, damage $900; Dewitt and Olive Townships, Clinton County, $400. Light falls of hail also occurred near Alpha.

June 22.—Severe hailstorm swept Ionia County, with damage estimated as follows: Berlin Township, $9,408; Sylvan Township, $5,400

June 23.—Moderate falls of hail fell over Ionia County, Sebewa Township, damage, $300; Campbell Township, $1,224.

June 30.—Near Newberry, in Pentland Township, Luce County, hailstones from one-quarter to three-quarters of an inch in diameter fell and remained on the ground for several hours. There was little apparent damage to crops.

July 2.—Light to serious hailstorms occurred from the southwest counties northeastward to Lake Huron, with damage estimated as follows:

Frazer Township, Bay County	$1,650
Garfield Township, Bay County	2,046
Piconning Township, Bay County	825
Ingersol Township, Midland County	750
Paris Township, Huron County	37,890
Bingham Township, Huron County	170
Bloomfield Township, Huron County	700
Chandler Township, Huron County	100
Verona and Meade Townships, Huron County	925
Union Township, Branch County	12,600
Waterford and Bloomfield Townships, Oakland County	4,356
White Lake Township, Oakland County	330
Avon Township, Oakland County	1,485
Denmark Township, Oakland County	24,200
Wheatland, Argyle, Custer, Lamotte, and Marlette Townships, Sanilac County	2,130
Rives Township, Jackson County	210
Leslie Township, Ingham County	325
Odessa Township, Ionia County	2,340
Burlington Township, Calhoun County	581
Grand Blanc Township, Genesee County	50
Fenton Township, Genesee County	369
Northfield Township, Livingston County	825

July 3.—Falls of hail were reported near Harrisville, in Harrisville Township, Alcona County, and Iron Mountain, in Breitung Township, Dickinson County; the damage was not given. Light hailstorms were also reported in two other counties, with damage estimated as follows:

Grout Township, Gladwin County	$480
Paris Township, Huron County	1,260
Bingham Township, Huron County	150

July 5.—Light to moderate visitations of hailstorms occurred, with estimated damage as follows:

Genesee Township, Genesee County	$50
Denmark Township, Genesee County	100
Lincoln Township, Isabella County	5,250

Severe hailstorm swept over Clinton County; estimated damage, Bengal Township, Clinton County, $10,080.

July 6.—Light falls of hail over two counties; damage estimated:

Clayton Township, Shiawassee County	$400.00
Fawn River Township, St. Joseph County	400.00
Munday and Gaines Townships, Genesee County	252.50
Clayton Township, Genesee County	225.00
Leslie Township, Ingham County	260.00

July 7.—Light hailstorms occurred over Genesee County; damage, Munday and Gaines Townships, Genesee County, $675.

July 9.—Light hailstorm over one county, with damage estimated, Northfield Township, Livingston County, $825.

July 10.—Moderate to severe hailstorms, with tracks sweeping eastward or northeastward in the central portion of the southern counties, with damage estimated as follows:

Sebewa and Danby Townships, Ionia County	$3,180
Keene Townships, Ionia County	180
Riley and Westphalia Townships, Ionia County	4,880
Bengal Township, Ionia County	300
Northfield Township, Ionia County	12,670
Green Oak Township, Ionia County	640

July 11.—A fall of hail was reported near Alma, in Arcada Township, Gartiot County; damage and intensity slight.

July 14.—Light to moderate fall of hail occurred over four counties; the paths moved northeastward; damage estimated:

Hayes Township, Clare County	$3,050
Macomb Township, Clare County	1,020
Quincy Township, Branch County	420
Allan Township, Hillsdale County	500

July 29.—Hail was reported near Escanaba in Ford Township, Delta County; the damage was negligible.

July 30.—A local hailstorm occurred near and in Alpena, in Sanborn Township, Alpena County, from 12:41 p. m. to 12:50 p. m., with stones measuring from a quarter to three-eighths of an inch in diameter; the damage was small and over a little area.

August 7.—A severe hailstorm swept over Washtenaw County:

Lima Township, Washtenaw County	$5,200
Lyndon Township, Washtenaw County	4,000
Sylvan Township, Washtenaw County	2,000

August 18.—The severest hailstorm of the year occurred over the east-central portion of the lower peninsula, the paths of the various disturbances traveling northeastward; damage as follows:

Coe and Chippewa Townships, Isabella County	$10,812
Lincoln Township, Isabella County	50,031
Fremont and Deerfield Townships, Isabella County	20,744
Deerfield and Broomfield Townships, Isabella County	1,625
Lake Township, Isabella County	1,500
Paris Township, Isabella County	1,900
Hume and Meade Townships, Isabella County	27,475

The disturbances over the following counties were much lighter:

Orange Township, Ionia County	$2,100
Forester Township, Sanilac County	350
Maple Valley, Sanilac County	100
Marion Township, Sanilac County	320
Munday and Gaines Townships, Genesee County	50

August 27.—A light hailstorm occurred near Allegan, in Allegan Township, Allegan County; damage not estimated. Also in Lincoln Township, Isabella County, $2,875.

August 28.—A moderate fall of hail visited one county; damage, Wakeshma Township, Kalamazoo County, $3,400.

August 29.—Light to moderate hailstorms, with estimated damage:

Athens Township, Calhoun County	1,883
Newton Township, Calhoun County	574
Burns Township, Shiawassee County	400
Wakeshma Township, Kalamazoo County	2,480
Argentine Township, Genesee County	125
Genesee Township, Genesee County	65
Nove Township, Oakland County	10,230
Bedford Township, Monroe County	2,500
LaSalle Township, Monroe County	700
Ida and LaSalle Townships, Monroe County	1,310
Ida and Bedford Townships, Monroe County	1,500
Bedford Township, Monroe County	3,450
Ida Township, Monroe County	14,465
Erie Township, Monroe County	2,250
Attica and Lapeer Townships, Lapeer County	900
Lake Township, Huron County	500

In Monroe County the damage was severe. The tracks moved northeastward or eastward.

September 1.—A light hailstorm visited Conway Township, Livingston County, with an estimated damage of $693.

September 12.—Hailstorms were quite prevalent over the upper peninsula and northern counties of the lower peninsula, but either crops were out of danger or the damage was very light. No damage was reported in any cases on this date. The localities were as follows: Near Deer Park, in McMillan Township, Luce County; near Hart Township, Oceana County, also Charlevoix County; near Grand Marais, in Burt Township, Alger County; Humboldt, in Humboldt Township, Marquette County; near Iron River, in Iron River Township, Iron County; near Munising, in Munising Township, Alger County; near Powers, in Spaulding Township, Menominee County; near Sidnaw, in Duncan Town-

ship, Houghton County; near St. Ignace, in Moran Township, Mackinac County; near St. James, in St. James Township, Charlevoix County; near Escanaba, in Escanaba Township, Delta County; near Houghton, in Houghton Township, Houghton County. No damage reported at any of these places.

September 13.—Hail occurred near Alpena, in Sanborn Township, Alpena County; near Benzonia, in Benzonia Township, Benzie County; near Frankfort, in Frankfort Township; near Munising, in Munising Township, Alger County; damage not reported. In Old Mission, Grand Traverse county; Sheridan Township, Huron County, damage $450.

September 14.—Hail was reported near Omer, in Arenac Township, Arenac County.

HEAVY HAILSTORM AND LOCAL SQUALL AT NEW ORLEANS, LA., WITH A SUMMARY OF THE PREVIOUS RECORDS OF HAIL

By R. A. DYKE, Meteorologist

[Weather Bureau Office, New Orleans, La., April 20, 1924]

A thunderstorm passed over New Orleans, La., on April 17, 1924, attended by a violent wind squall and a remarkable heavy fall of hail, which has led to an examination of the record of hail at this station.

Hail has fallen in New Orleans or its immediate vicinity about once a year, on the average. About 70 per cent of the occurrences of hail have been during the five-month period, March to July; January and February contribute 20 per cent, leaving 10 per cent equally divided among the remaining months except October, which has thus far no recorded occurrence of hail at New Orleans. The period of most frequent thunderstorms, embracing the summer months, is not the time of most frequent occurrence of hail in this locality. A total of 13 hailstorms has been recorded for the five months, May to September, while 18 have been recorded in March–April.

No hailstorms have been recorded at New Orleans for the morning hours between 4 and 8 o'clock, this being the time of day least favorable for the occurrence of thunderstorms. The apparent explanation for this fact is that cooling of the air nearest the ground at night opposes upward convection, so that traveling convective storms, which usually develop several hours earlier, generally exhaust their energy before early morning; and thunderstorms can not usually build up to any great height under the conditions prevailing from 4 a.m. to 8 a.m. It requires a well-developed thunderstorm to produce a fall of hail. It is interesting to note that 60 per cent of the recorded occurrences of hail in this locality have been between noon and 7 p. m. and 40 per cent from 7 p. m. to 4 a. m. A few occurrences of light hail were probably overlooked at night because comparatively few people are awake during certain hours, but in a large city the percentages given could not be much in error from this cause. Only a few of the recorded hailstorms were heavy and damaging, and these occurred late in the afternoon or early in the night and during the spring months.

Previous to the recent storm, the heaviest falls of hail in New Orleans occurred on April 16, 1879, and March 17, 1904; but these were far less heavy and damaging than the hail of April 17, 1924.

In the evening of April 17, 1924, an hour previous to the storm a narrow and rather shallow trough of low pressure was passing the station, with barometer reading of 29.81 inches, sea level, at New Orleans at 7 p. m. The temperature difference in the front and rear of this trough was slight at the earth's surface; the thermograph trace shows a fall of only 5° F. from before the storm to about an hour after. At the Weather Bureau office, which is near the southern limit of the path of hail, there was less indication of disturbed pressure conditions than is registered with many mild thunderstorms. The pressure rose at a moderate rate and apparently continuously, with only a very slight increase in the rate of rise at the time of the storm. Thunder and lightning of a mild character occurred in the neighborhood of the office. The maximum recorded wind velocity was 18 miles an hour at 8:15 p. m. to 8:20 p. m. and scattering hail fell from 8:10 p. m. to 8:15 p. m., the hailstones being 2 inches in diameter or somewhat larger.

The path of the hail was about 6 miles wide and 25 miles long. Hail began just east of Kenner, La., shortly before 8 p. m. and passed rapidly eastward as far as Chef Menteur, lasting not more than 5 to 10 minutes at the various places along the path. The entire city of New Orleans, except the extreme southern portion where the river bends to the south, was in the path of the hail, and numerous reports were received of the hailstones fully 3 inches in diameter. In a few places the hail on the ground was reported to be 4 inches deep, impeding the advance of an automobile at North Broad and St. Bernard Streets. Many buildings have a spotted appearance on the west side, showing where the paint was knocked off. Damage of about $7,000 was done to glass and plants of florists and in gardens. Other damages, difficult to estimate, resulted from broken windows in dwellings and other buildings; but the path of such damage was considerably smaller than the path of the hail.

The central part of the front of the thunderstrom was marked by a wind squall from the west-northwest, which reached almost tornadic force in the extreme western portion of the city and the adjoining suburbs near the upper protection levee. Numerous small houses were moved from their foundations, and several lightly built houses were scattered and destroyed. The roofs of many other houses were damaged, giving entrance to heavy rain, which increased the damage. The total losses from wind and rain may be conservatively estimated at $100,000.

The most serious injury reported was a fractures leg, suffered by a woman in a house which was blown to pieces. Lesser injuries, due to wind or hail, occurred to about 50 other persons. To persons who viewed the wreckage, it appeared remarkable that there were no deaths or no worse injuries than occurred.

SEVERE HAILSTORM AT CORPUS CHRISTI, TEX.[1]

The most severe hailstorm that has visited the immediate vivinity of Corpus Christi occurred between 1:10 and 2 a. m., May 10. Hail, averaging a half inch in diameter, fell nearly continuously for almost an hour, associated with strong north winds, vivid lightning, and torrential rainfall (1.65 inches in 38 minutes).

The greatest damage was sustained in Corpus Christi; one greenhouse was completely destroyed, as if riddled by buckshot; dwelling houses on Nueces Bay Heights suffered loss and damage through breaking of windows and flooding of the interior by the rain. The total loss from the storm is estimated at $15,000.

The path of the storm was a mile wide and 6 miles long. The intensity of the storm decreased very much as it moved west of Nueces Bay Heights.

[1] Condensed from a report by J. P. McAuliffe, Meteorologist.

HAILSTONES OBSERVED AT BUDAPEST JULY 13, 1922

By A. RÉTHLY

On July 13, 1922, toward evening, dark clouds approached quickly from the NW. Arriving above the town, thick hail and rain showers poured down, accompanied by weak thunder. The hailstones soon covered the flower stand before the window, and plenty of them could be gathered. The quantity of precipitation during the thunderstorm amounted to 5.6 mm. (0.2 inch) and according to the records of the ombrograph the rain lasted 10 minutes.

The hailstones were of diverse shape; some of them had a substantially spherical structure, others had, besides the spherical shelled feature, also a radial structure. All were soft and light, and when falling to the ground they got flattened; many of the hailstones had a pronged border and some of them had protrusions of the length of 6 to 8 mm. I made sketches from some of the selected hailstones and Mr. Tihamér Kuharszky had the kindness to draw (according to my instructions) the accompanying figures which show the hailstones in natural size. Some of them remind us of those which we observed in Ó Gyalla on April 26, 1903 (Hann: Lehrbuch der Meteorologie III edition, p. 709).

From the five hailstones selected seven drawings appear on the accompanying plate (fig. 1), to which I beg to make the following observations:

1. A larger hailstone, which has a larger air bubble at its center and many minor air bubbles around it. This hailstone was composed of two very sharply limited parts: An exterior part, clean white, and the inner part built up of spherical shells which surrounds the kernel containing the air bubble.

2. A hailstone of very pronged border, some of the protruding parts were of 4–5 mm. length. The inner white kernel, opaque and milk colored, was surrounded by an exterior water-clear ice layer.

3. A larger inner kernel, white and opaque, filled with small air bubbles; the exterior transparent shell has a very fine radial structure.

4. Formless hailstone filled with small air bubbles and bearing several larger protruding parts. In the central part an opaque, milk-colored kernel.

5. This is the most fantastically shaped hailstone of all. Figure *a* shows the side view; we see here protruding horns, which acquire the length of 7 mm. on the right side, a length of 4 mm. and a breadth of 3–4 mm. on the left side. The interior part is of a spherical shelled structure, the innermost shell surrounding the kernel is distinctly radial and white, the outer part is transparent and feebly radial. The kernel is clear white. Figure *b* is the same hailstone as seen from above. Figure *c* is the cross section of the hailstone. The kernel is surrounded by a transparent ice shell, embraced by a milk-colored shell, which is surrounded by opaque ice. This hailstone was thus composed of four layers which could be sharply distinguished.

TORNADOES FROM ARKANSAS TO VIRGINIA, APRIL 29–30, 1924

By HERBERT C. HUNTER

[Weather Bureau, Washington, D. C., June 2, 1924]

The most notable group of tornadoes in the United States for some years occurred within a period of about 26 hours, late in April, in the Southern and Southeastern States. The low-pressure area concerned was the one which is designated XI *A* in the chart of tracks of cyclones in this issue. The center of the LOW was near Wichita, Kans., on the morning of Tuesday, the 29th, with minimum reading 29.44 inches; north of Little Rock, Ark., 12 hours later, with reading 29.46 inches; near Louisville, Ky., on the morning of the 30th, reading 29.38 inches; and southeast of Pittsburgh, Pa., the evening of the 30th, with reading 29.34 inches. (All pressure readings are reduced to sea level.)

The hours of occurrence were from 2:30 p. m., 90th meridian time, of the 29th, to 5:30 p. m., 75th meridian time, of the 30th. It is thought there were 21 distinct tornadoes, in numbers by the States in which they originated, thus: Arkansas, 1; Louisiana, 2; Alabama, 5; Georgia, 8; South Carolina, 1; North Carolina, 2; Virginia, 2. One storm starting in Alabama continued into west-central Georgia, and another of great importance from northeastern Georgia followed a long path across northern South Carolina.

There is considerable possibility of two other tornadoes, in Georgia and South Carolina, respectively. As usual in the southeastern quadrants of well-developed LOWS, there were many thunderstorm gusts and hailstorms not far distant from the tornadoes.

The three tornadoes of the afternoon of the 29th were nearly in a north-south line; but the first one, in southwestern Arkansas, was slightly farther to the west than the others. The times of the northern and the southern were 2:30 p. m. and 6:30 p. m., respectively; the places of the three, a little north of Texarkana, Ark., Crichton, La., and Many, La.; the intervals, in miles, from north to middle, about 100, and from middle to south, 40. The Texarkana tornado advanced northeastward, but the Many one to eastward; the tracks were narrow, except for the Many storm, the path of which varied from a quarter mile to a half mile in width, and was a few miles long. The Texarkana and Many storms caused one death each, and in all three cases there were people injured and buildings wrecked, the property loss being greatest at Many.

The office at Shreveport is between Texarkana and Crichton, considerably nearer the latter. The strongest wind of both day and month occurred there shortly before noon, the lowest barometer of both day and month at 3:40 p. m., and there was a brief thunderstorm, not especially notable, with hardest rain very close to 4 p. m.

After an interval of about eight hours tornado activity was resumed almost 400 miles to eastward of Many. Autaugaville, Autauga County, is in central Alabama, and here the storm occurred at 2:45 a. m. of the 30th; the damage amounted to $30,000 and two persons were slightly hurt. It may have been this same tornado which struck a locality 90 miles distant, in direction from Autaugaville between northeast and east-northeast, at 4:30 a. m., but it seems better to count this later occurrence as a distinct storm. The locality is near the northern edge of Chambers County, between Welsh and Roanoke, not far from the Georgia border, but the tornado apparently did not even reach the State line. This locality suffered one death, several injuries, and damage of fully $25,000.

Soon after the tornado passed near Welsh, two new tornadoes formed well to the southward of a line joining Autaugaville and Welsh. The more western was at Greenville, Butler County, at 4:50, and what was probably the same storm was 50 miles to northeastward, in northwestern Bullock County, an hour later, and in southeastern Macon County at 6:30. Great property loss and 8 deaths resulted from this tornado, which was about 40 miles distant from Autaugaville at a time 150

(To face p. 206)

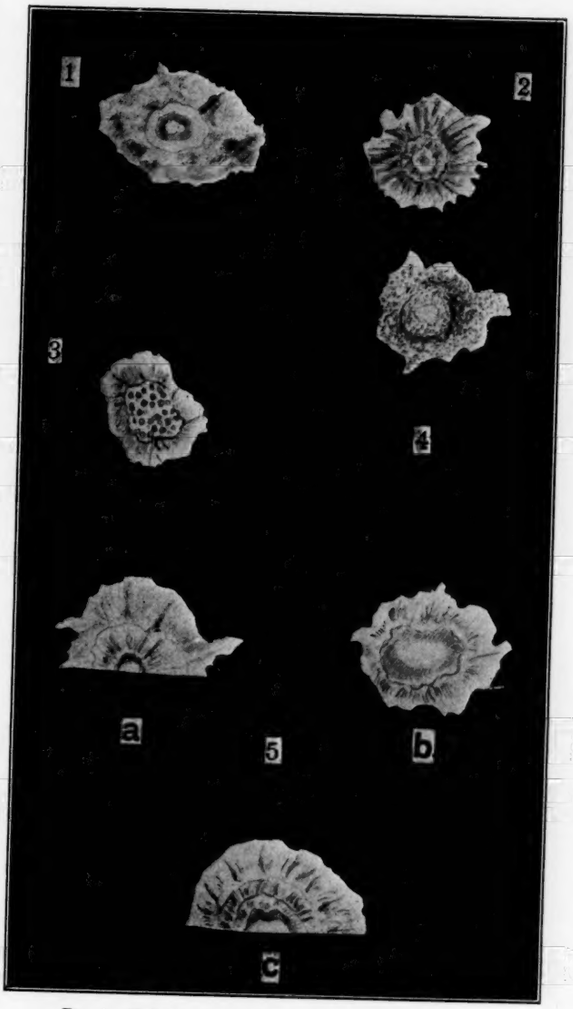

FIG. 1.—Hailstones observed at Budapest, July 13, 1922

minutes later than the earlier tornado at that place. The more eastern of the new tornadoes was 25 miles distant when nearest Welsh and about 50 minutes later (5:20 a. m.); this tornado had formed about 5, in southern Lee County, and is probably the storm which struck Chipley, Ga., and Warm Springs, Ga. The times reported are 6:15 at Warm Springs and 8:30 at Chipley; but the latter is thought to be in error, otherwise there would seem to have been a later tornado, probably of short path, practically on the path of a long, earlier storm. The Lee County to Warm Springs storm moved nearly 50 miles northeastward; 15 deaths resulted, 11 of them in Georgia.

The final Alabama tornado was reported in Pike and Barbour Counties at times from 6 to 7:15, and seems to have moved but very slightly north of due east; 1 death resulted. This storm was about an hour later than and 35 miles southeast of the Bullock County tornado.

In Georgia at this time there seem to have been more distinct tornadoes than in any other one State—9 in all, but only 7 wholly within the State. The movement was usually to east-northeastward, but in some cases nearly due east. The hours of occurrence, when charted, give puzzling results, departing considerably from the orderly geographic sequence which is found in most other States.

The tornado from Alabama which reached Warm Springs came into Georgia at 5:30, 90th meridian time. So the first tornado activity in Georgia was at Lawrenceville, Gwinnett County, at 6, 75th meridian time.

This place is several miles northeast of Atlanta, and is considerably farther north than the path of any tornado previously mentioned. This tornado seems to have advanced 185 miles in all, but reached the ground only at intervals; the property losses are found as $2,200,000, or somewhat more than the damage of all the other tornadoes of the two days combined. It reached Royston, Ga., 55 miles from Lawrenceville, at 7 and 20 miles beyond crossed into South Carolina. Anderson was reached just after 9, and here there was great property loss, while 8 persons were killed. The southern part of the city was traversed and two large mills were considerably damaged. East of Anderson the tornado did damage in or near Eden, Gray Court, Moore, and Walnut Grove, and was last reported as being near Hickory Grove about 11 a. m. As Walnut Grove and Hickory Grove are several miles north of a line drawn close to Anderson and Gray Court, it is possible that there were two distinct tornadoes in this part of South Carolina during the latter part of the forenoon. Only 1 death—in Georgia—is attributed to this storm, or these two storms, outside of Anderson.

The 7 tornadoes wholly in Georgia are reported as occurring at the places and hours named, the times being 75th meridian save in the two cases where "(90th)" follows: Albany, 7:10 (90th); Brookton to Cornelia, 9 to 9:35; Reynolds, 8:30 (90th); Ficklin, 9:30; Macon, southern suburbs, 9:30; Fitzgerald, 10; and Sylvania, 12:45—this last alone being after noon. The deaths resulting were 1 at Ficklin and 3 at Macon. Damage to property was $200,000 at Macon; $50,000 each at Cornelia and Fitzgerald; but elsewhere less, and especially little at Albany and Sylvania. There is a slight chance that the Albany and Fitzgerald tornadoes were merely separate appearances of a single storm; otherwise, consideration of the locations and hours leads to the belief that the storms were independent.

The official in charge at Macon, Harry Raynes, has furnished a report of the storm near that city, from which these statements are extracted:

> At 9:02 thunder was first heard, the storm being in the south-southwest. Small hail fell from 9:17 to 9:22, and about this time the rain increased from gentle to heavy. The wind shifted to northwest and west-northwest at 9:26. During the hard rain and for a half hour after it ceased, small twigs, leaves, pine cones, and pine needles were falling from a great height. (The nearest pine trees are a mile and a half distant.)
>
> Shortly before 10 a. m. a dark, squirming, funnel-shaped cloud in the east-southeast was visible from the office window for about a minute.
>
> A close eyewitness described the clouds as a spiral, funnel-shaped, whirling mass, demolishing everything in its path of not more than 300 yards in width. About the top of this mass of clouds there was observed a continuous display of electrical phenomena, accompanied by loud detonations of reverberating thunder.
>
> Signal posts of the Central of Georgia Railway, built of steel, embedded in concrete, which is buried 4 feet in the ground, were lifted out of the ground and twisted. The posts are said to weigh more than a ton each.

Between the times of the Fitzgerald and the Sylvania tornadoes in Georgia, and about the time that the northern tornado in South Carolina was ending, the severe southern tornado was starting. This followed a path about 60 miles to southward of the northern one, and was about 100 minutes later at points abreast.

Starting about 11 miles northeast of Aiken, Aiken County, at 11 a. m., the tornado was last observed 135 miles away, in direction east by north, near Pamplico, Florence County, at 2:45 p. m. It passed through or near Edmund, Lykesland, Horrell, Horatio, Dalzell, Dubose, Wisacky, and Lamar, but no large community was encountered, so, in spite of the width of path, sometimes as great as 1,400 yards, the damage was only about $1,000,000. But the loss of life was 67, greater than from any previous tornado in South Carolina, as far as records have revealed.

While this disastrous storm was moving across South Carolina, there were 2 short tornadoes in North Carolina. The earlier, at 12:30 p. m., was north of Pittsboro, in Chatham County; it traveled 2 miles northeastward and caused 4 deaths and property loss of $20,000. The later started slightly more than 100 miles to eastward of Pittsboro, being southwest of Robersonville, Martin County, about 2:30 p. m.; its movement was 15 miles to northeastward, and it resulted in damage of $200,000 and 1 death.

The last two tornadoes occurred in southeastern Virginia. About 5:30 p. m. there was a path of moderate length, about 10 miles, in Amelia County, from southwest to northeast. The greatest damage was at Maplewood, near where the storm started, where several were injured, one man fatally. The total damage done by this storm was $30,000. The place of occurrence was 130 miles to northeastward of the western North Carolina tornado, and nearly as great a distance northwestward of the eastern North Carolina storm. The other Virginia tornado occurred about the same time, 50 miles southeastward of Amelia County, near Pleasantshade, Greensville County; it was short and of narrow path, but by destroying a building it caused about $1,000 damage.

The loss of life in these 21 storms was 114, and the total damage, conservatively estimated, with reports lacking as to a very few points where probably it was small, foots up a little more than $4,000,000.

VARIATIONS IN HOURLY RAINFALL AT LINCOLN, NEBR.

HARRY G. CARTER, Meteorologist
[Weather Bureau Office, Lincoln, Nebr., May 16, 1924]

Since the advent of rain insurance there has been an increasing demand for hourly precipitation data. Insurance companies can not establish a satisfactory rate for rain insurance without a full knowledge of hourly rainfall frequency and intensity. These values are not the same for all months of the year, nor for all localities during the same month. For instance, to make a satisfactory rate for rain insurance for Lincoln it is necessary to know that during May more than twice as much rain falls as during October; that May has 50 per cent more hours with rain than October; that the average shower in October lasts 25 minutes longer than the average shower in May; that the time of greatest rain probability is between midnight and 6 a. m. in May, and the time of least probability is between noon and 6 p. m. in August.

This information is of value, not only to insurance companies, but can be used to advantage in many lines of work. Outdoor activities can be planned to better advantage if the average daily weather conditions are known. This is being recognized and the demand for average weather conditions is steadily increasing. With this in mind a rather extended study was made of the hourly rainfall at Lincoln and the results summarized somewhat in detail.

The data presented in this paper cover the 19 years 1905 to 1923 and are for the period May 1 to October 31. In computing the average duration of rains, however, the record for April was also included. The automatic record of hourly rainfall is not maintained regularly during the remainder of the year. Snow fall can not be measured by the automatic rain gauge, nor can the gauge be maintained during freezing weather. Occasionally the record for the automatic gauge is kept during parts of April and November, but with insufficient regularity to be of any value in computing hourly averages.

Tables 1 and 2 show the accumulated amounts of precipitation for each hour of the day for the months May to October, inclusive, for the 19 years. The most noticeable feature is the greater amount of water falling during the night as compared with what falls during the day.[1] For the entire period about 34 per cent of the total amount falls during the 12 hours 6 a. m. to 6 p. m., and about 66 per cent from 6 p. m. to 6 a. m. The ratio differs with the different months, 74 per cent of the August precipitation occurs during the night hours, while in October 53 per cent falls at night and 47 per cent during the day. Considering six-hour periods, the greatest per cent of accumulated precipitation for the different months is to be found from midnight to 6 a. m. in August, averaging 45.5 per cent of the total for the month, while from noon to 6 p. m. in August but 6.6 per cent of the total monthly precipitation is recorded. The greatest difference between the amounts accumulated during day and night is in August, averaging 48 per cent more for the night rains, and the least difference is in October, when the night rains average but about 6 per cent more than the day rains.

Tables 3 and 4 and Figures 1–7 show the frequency of rain at the different hours. By frequency is meant the per cent of times rain equaling or exceeding 0.01 inch falls within the hour. A check was made during the entire period of the hours with a trace or more rain, and it was found that in about 44 per cent of the hours with rain the amount was only a trace. As a trace is an amount of rain less than 0.005 inch, it would in most cases be but a light sprinkle, and in some cases but a few drops. As these amounts are too small to affect outdoor activities, it was decided in determining rainfall frequency to consider only hours when the amount of rain equaled or exceeded 0.01 inch.

The month of greatest rainfall frequency is May, and the month of least frequency is August, with July a close second. There is a gradual decrease of rain probability from May to August, with an increase in September and a decrease in October. The greatest frequency is during the night hours, averaging 5.8 per cent, as compared with 4 per cent during the daylight hours. The greatest probability during the night is in May, with an average of 7.8 per cent, and the least during the day is in July, averaging 2.9 per cent. Considering the 6-hour periods, the probability is greatest between midnight and 6 a. m. in May (8.3 per cent), and least between noon and 6 p. m. in August (2.2 per cent) and July (2.5 per cent). The rainiest single hour is between 2 a. m. and 3 a. m. in June (9.5 per cent) and in May (9 per cent). The least probability is between 2 p. m. and 3 p. m. in August (1.2 per cent) and from 1 p. m. to 2 p. m. in July (1.5 per cent). The greatest difference between the day and the night rain frequency is in June, day rains averaging 4 per cent and night rains 7.2 per cent. From June the difference gradually decreases to October, when the day rains average 4.3 per cent and the night rains 4.5 per cent.

TABLE 1.—*Hourly amounts of accumulated precipitation, May to October, inclusive, for the 19 years 1905 to 1923, at Lincoln, Nebr.*

MONTH	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
May	7.67	3.37	2.76	3.24	3.65	2.74	3.22	1.95	1.90	1.49	1.41	0.84	1.65	2.20	1.71	1.33	2.35	4.17	5.24	3.58	3.86	3.47	3.90	4.14
June	6.70	5.51	5.33	4.84	3.31	2.34	3.14	1.26	1.19	2.07	1.52	1.51	1.91	2.38	1.56	1.37	1.23	2.47	2.31	4.70	5.08	6.79	6.53	5.96
July	3.14	5.96	2.77	3.12	3.96	2.06	1.99	2.66	2.54	1.79	1.88	1.98	0.85	0.84	1.31	1.15	3.05	3.89	5.52	1.93	3.45	5.41	3.12	4.31
August	3.92	5.37	8.13	6.33	5.49	4.05	5.58	4.02	1.31	0.92	1.92	0.91	0.31	0.30	0.23	1.44	0.69	2.03	2.81	2.57	5.07	3.33	4.02	3.67
September	4.31	5.80	7.81	5.21	4.04	2.99	3.07	2.93	2.42	2.51	1.98	1.72	1.11	1.35	1.41	4.25	3.13	2.49	3.34	3.26	2.50	1.90	3.65	4.04
October	1.35	1.24	2.26	1.44	1.33	1.02	0.89	0.90	0.74	1.15	0.99	1.67	1.24	1.49	1.58	1.75	1.84	1.76	1.82	1.05	1.86	2.06	1.35	1.40
Mean	5.42	5.45	5.81	4.84	4.36	3.24	3.58	2.74	2.02	1.99	1.94	1.73	1.41	1.71	1.56	2.26	2.46	3.36	4.21	3.42	4.36	4.59	4.51	4.70

TABLE 2.—*Percentage of total monthly precipitation occurring during 6-hour periods, May to October, inclusive, at Lincoln, Nebr.*

Month	Midnight to 6 a. m.	6 a. m. to noon	Noon to 6 p. m.	6 p. m. to midnight
	Per cent	*Per cent*	*Per cent*	*Per cent*
May	32.6	15.0	18.7	33.7
June	34.6	13.2	13.5	38.7
July	30.6	18.7	16.1	34.6
August	45.5	19.4	6.6	28.5
September	39.1	18.9	17.8	24.2
October	25.3	18.5	28.3	27.9
Mean	34.6	17.3	16.8	31.3

[1] Cf. Kincer, J. B. Daytime and nighttime precipitation. MONTHLY WEATHER REVIEW, 44; 628-633.

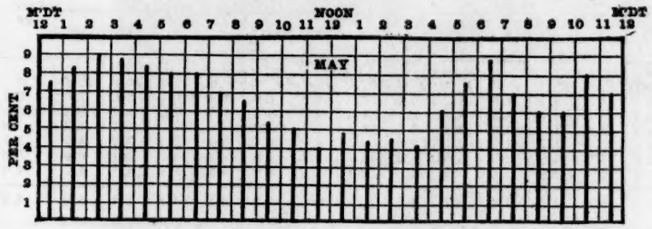

FIG. 1.—Percentage of time rain, equaling or exceeding 0.01 inch, is recorded each hour, at Lincoln, Nebr., during May

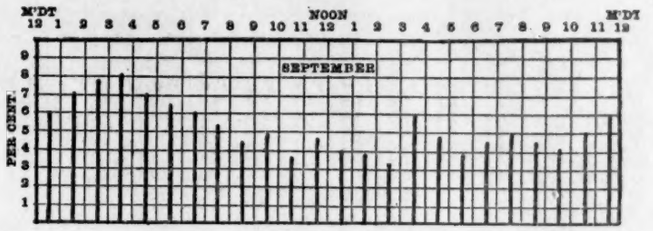

FIG. 2.—Percentage of time, rain, equaling or exceeding 0.01 inch, is recorded each hour, at Lincoln, Nebr., during June

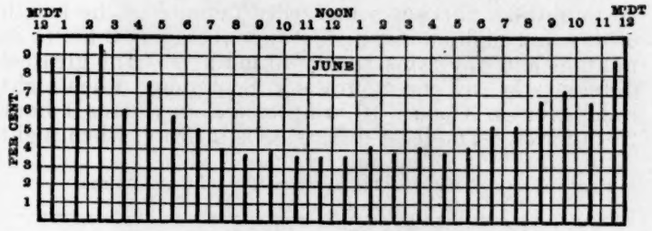

FIG. 3.—Percentage of time rain, equaling or exceeding 0.01 inch, is recorded each hour, at Lincoln, Nebr., during July

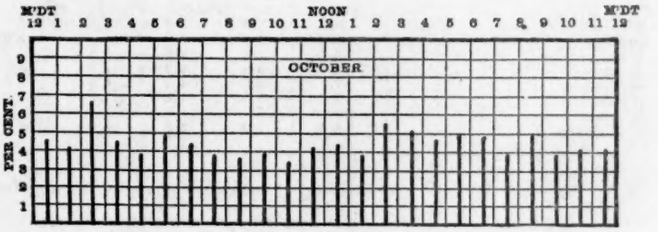

FIG. 4.—Percentage of time rain, equaling or exceeding 0.01 inch is recorded each hour, at Lincoln, Nebr., during August

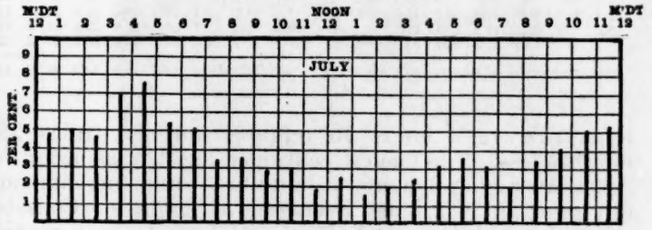

FIG. 5.—Percentage of time rain, equaling or exceeding 0.01 inch, is recorded each hour, at Lincoln, Nebr., during September

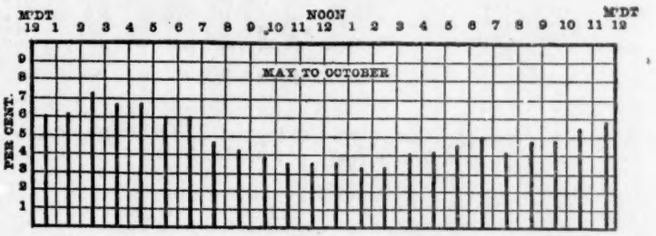

FIG. 6.—Percentage of time rain, equaling or exceeding 0.01 inch, is recorded each hour, at Lincoln, Nebr., during October

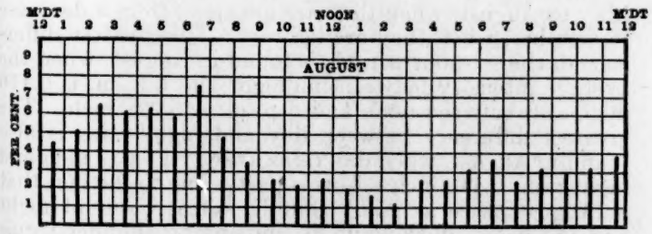

FIG. 7.—Percentage of time rain, equaling or exceeding 0.01 inch, is recorded each hour, at Lincoln, Nebr., during May to October, inclusive

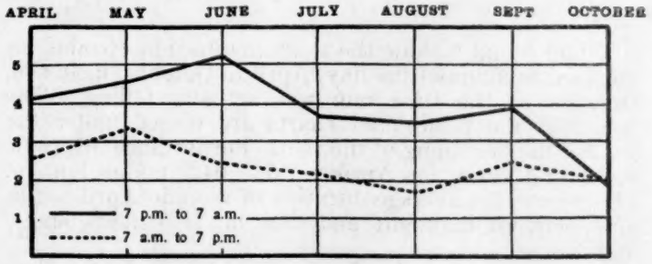

FIG. 8.—Average monthly number of rainfalls equaling or exceeding 0.10 inch

TABLE 3.—*Percentage of times rain equaling or exceeding 0.01 inch is recorded each hour at Lincoln, Nebr. (for the hour ending with those given)*

Month	A. M.												P. M.												Average
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
May	7.5	8.3	9.0	8.8	8.3	8.0	8.0	7.0	6.5	5.3	5.1	4.1	4.8	4.4	4.6	4.2	6.1	7.6	8.8	7.0	6.1	6.1	8.0	7.0	6.7
June	8.8	7.8	9.5	6.0	7.6	5.8	5.1	4.0	3.7	3.9	3.7	3.7	3.7	4.2	3.9	4.2	3.9	4.2	5.3	5.3	6.7	7.2	6.7	8.8	5.6
July	4.8	4.9	4.6	7.0	7.5	5.3	5.1	3.4	3.6	2.9	2.9	1.9	2.4	1.5	2.0	2.4	3.2	3.7	3.1	2.0	3.4	4.2	5.1	5.3	3.8
August	4.4	5.1	6.5	6.1	6.3	5.8	7.5	4.8	3.4	2.5	2.2	2.5	2.0	1.7	1.2	2.5	2.5	3.1	3.7	2.4	3.1	2.9	3.2	3.9	3.7
September	6.0	7.1	7.8	8.1	7.1	6.5	6.1	5.3	4.4	4.9	3.7	4.6	4.0	3.9	3.3	6.0	4.7	3.9	4.4	4.9	4.6	4.2	5.1	6.0	5.3
October	4.4	4.1	6.5	4.4	3.9	4.9	4.4	3.9	3.6	3.9	3.4	4.2	4.4	3.9	5.4	5.1	4.6	4.9	4.9	3.9	4.9	3.9	4.1	4.2	4.4
Mean	6.0	6.2	7.3	6.7	6.8	6.0	6.0	4.7	4.2	3.9	3.5	3.5	3.6	3.3	3.4	4.1	4.2	4.6	5.0	4.2	4.8	4.8	5.4	5.9	4.9

TABLE 4.—*Percentage of times rain equaling or exceeding 0.01 inch is recorded each hour, for 6-hour periods, at Lincoln, Nebr.*

Month	Mid. to 6 a. m.	6 a. m. to noon	Noon to 6 p. m.	6 p. m. to mid.	Average
	Per cent	Per cent	Per cent	Per cent	Per cent
May	8.3	6.0	5.3	7.2	6.7
June	7.6	4.0	4.0	6.7	5.6
July	5.7	3.3	2.5	3.8	3.8
August	5.7	3.8	2.2	3.2	3.7
September	7.1	4.8	4.3	4.9	5.3
October	4.7	3.9	4.7	4.3	4.4
Mean	6.5	4.3	3.8	5.0	4.9

TABLE 5.—*Average duration of rains beginning at the different hours at Lincoln, Nebr. (for the hours ending with those given)*

Month	A. M.												P. M.												Av.
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.	H. m.
April	5 42	55 3	52 4	10 1	43 3	1 2	40 2	13 1	15 7	6 2	52 2	18 1	43 2	31 2	37 2	53 1	34 2	47 4	06 3	27 1	54 5	48 2	33 2	42 3	04
May	2 40	2 25	3 21	2 18	2 24	1 4	1 23	2 19	1 22	1 18	2 29	2 25	4 03	1 36	4 16	0 47	3 12	1 48	1 29	3 16	3 34	1 28	3 16	4 39	2 27
June	2 22	1 52	1 58	0 43	1 23	1 44	0 59	1 31	1 34	1 14	0 53	1 46	1 54	0 56	0 58	1 7	1 56	1 20	1 15	1 21	2 38	3 15	2 39	3 22	1 42
July	2 35	3 04	2 00	1 52	1 53	1 23	1 20	1 24	1 38	0 56	1 32	0 45	0 42	0 54	0 52	0 56	1 35	0 44	1 19	1 16	2 23	2 55	1 50	1 46	1 34
August	2 19	2 04	1 44	1 32	0 59	1 22	0 48	1 22	1 03	1 07	1 49	0 25	0 46	0 33	0 41	0 50	0 50	0 18	0 54	1 49	3 27	2 06	0 51	2 34	1 21
September	2 55	3 48	1 34	2 58	1 52	2 46	1 17	1 13	1 20	1 28	2 23	1 01	1 27	1 39	1 21	1 19	1 14	1 58	1 55	4 17	2 34	4 30	6 22	2 31	2 19
October	4 50	6 01	1 43	2 55	2 18	2 28	1 53	3 28	1 05	1 27	2 16	5 32	1 51	5 24	1 32	2 50	2 25	1 30	3 12	4 20	2 35	2 45	2 35	2 05	2 52
Average	3 15	3 10	2 19	2 21	1 47	1 58	1 29	1 56	1 20	2 05	2 02	2 02	1 47	1 56	1 45	1 32	1 49	1 29	2 01	2 49	2 44	3 15	2 52	2 48	2 11

TABLE 6.—*Average duration of rains beginning at the different hours, for 6-hour periods, at Lincoln, Nebr.*

Month	Mid. to 6 a. m.	6 a. m. to Noon	Noon to 6 p. m.	6 p. m. to Mid.
	H. m.	H. m.	H. m.	H. m.
April	3 28	3 04	2 21	3 25
May	2 22	1 53	2 37	2 57
June	1 40	1 20	1 22	2 25
July	2 08	1 16	0 57	1 55
August	1 40	1 06	0 40	1 57
September	2 39	1 27	1 29	3 42
October	3 22	2 37	2 35	2 55
Average	2 28	1 49	1 43	2 45

Tables 5 and 6 show the average duration of rains for the various hours of the day, April to October, inclusive. Duration is the time rain was actually falling. The values in the tables and charts are placed under the hour of the beginning of the rain. For instance, in Table 5 the first entry for April is "5 04," under 1 a. m. This means the average duration of rains in April beginning between midnight and 1 a. m. is 5 hours and 4 minutes.

The average length of rains in April is longer than the rains of any other month. Light drizzles of several hours' duration are not uncommon, lengthening the average duration somewhat. From April there is a decrease in the length of rains until August, when they are shortest, and then an increase to October. The rains of June, the month of the greatest number of thunderstorms, average 1 hour and 42 minutes in duration, slightly longer than the rains of July and August. The average duration of summer rains is 1 hour 32 minutes, while the rains of spring and autumn average 2 hours 40 minutes. There is a marked difference in the length of day and night rains, night rains averaging 2 hours 36 minutes and day rains 1 hour 46 minutes. The greatest difference in any one month is in September, when night rains average 3 hours 10 minutes and day rains 1 hour 28 minutes. The least difference is in May, when night rains average 2 hours 40 minutes and day rains 25 minutes less. The longest continued night rains occur in April, averaging 3 hours 26 minutes, while the shortest day rains are in August, averaging 53 minutes. Considering the period as a whole, there seems to be a maximum duration just before and after midnight and again about 10 a. m., and a minimum about 6 a. m. and 3 p. m.

Tables 7 and 8 show the hourly intensity. This is obtained by dividing the accumulated amount of precipitation for each hour by the number of times rains of a trace or more occurred during the hour.

There is a gradual increase in intensity of rains from May to August, when they are heaviest; than a decrease to October, when they are lightest. The greatest difference in the six-hour periods is found in August, when the average intensity between midnight and 6 a. m. is 0.116 inch, and between noon and 6 p. m. is 0.028 inch. The greatest difference between day and night rains is also found in August, when day rains averaged 0.039 inch and night rains 0.110 inch. This is partly due to the fact that in August twice as many thunderstorms occur at night and the heavy downpours accompanying thunderstorms raise the average intensity. During May and October, when thunderstorms are fairly evenly distributed throughout the day and night hours, the difference in intensity between day and night is small. October shows no heavy downpours and but a small variation in day and

night rains. During the summer months heavy night rains are more frequent than during spring and autumn. The day rains of summer, however, are but little heavier than day rains of spring and autumn.

As many insurance companies insure against 0.10 inch of rain, Figure 8 is presented, which gives the average number of times each month a rainfall equaling or exceeding 0.10 inch was recorded during the 12-hour periods ending at 7 a. m. and at 7 p. m. for the 19 years 1905 to 1923. During June night rains equaling or exceeding 0.10 inch were recorded an average of 5.2 times. The greatest number of day rains were recorded in May (3.4) and the least in August (1.8). In October day rains of 0.10 inch or more were slightly more frequent than night rains, the average being 2.1 for day rains and 1.9 for night rains.

The records for the 19 years studied indicated clearly that from May to October night rains at Lincoln were uniformly of more frequent occurrence, of longer duration, and of greater intensity than day rains.

a distribution of rain just opposite of what would be expected. The average fall of rain at Topeka from 5 a. m. to 6 a. m. is more than three times as great as from noon to 1 p. m., and this surprising fact is confirmed by the amounts credited to adjacent hours. More than 60 per cent of the average day's precipitation occurs between 6 p. m. and 6 a. m.[1]

This distribution of precipitation becomes an important matter, especially in the summer months, when most outdoor activities take place. Practically everything done outdoors is subject to interruption or delay by rain. Were the wettest hours at Topeka in the afternoon instead of at night, many lines of human endeavor would be more hampered by unseasonable weather than they now are. Fields and the great stretches of unsurfaced highways dry out rapidly in the warm season of the year in the Middle West, and often after a heavy rain at night field work of certain kinds can be resumed the next day and motorists find properly graded dirt roads passable after a few hours sunshine.

TABLE 7.—*Average hourly intensity of rainfall at Lincoln, Nebr. (for the hour ending with those given)*

[Total hourly accumulated divided by number of times rain is recorded during the hour]

Month	A. M.												P. M.												Average
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
May	0.108	0.043	0.033	0.042	0.045	0.037	0.039	0.022	0.028	0.025	0.025	0.014	0.025	0.038	0.029	0.024	0.035	0.056	0.069	0.046	0.058	0.055	0.055	0.063	0.042
June	.093	.086	.066	.058	.053	.040	.060	.024	.027	.058	.039	.038	.040	.051	.034	.029	.024	.024	.046	.089	.098	.119	.109	.090	.058
July	.070	.132	.058	.050	.067	.039	.038	.059	.062	.053	.048	.060	.028	.026	.037	.035	.080	.105	.149	.088	.101	.159	.074	.086	.071
August	.096	.122	.163	.122	.096	.095	.086	.082	.028	.022	.055	.030	.009	.009	.010	.060	.020	.062	.078	.092	.127	.085	.130	.105	.074
September	.085	.094	.113	.090	.072	.051	.045	.047	.046	.049	.049	.048	.024	.029	.030	.082	.065	.053	.074	.069	.054	.044	.081	.082	.062
October	.031	.025	.044	.028	.030	.023	.019	.017	.015	.024	.021	.039	.025	.030	.026	.030	.035	.033	.030	.018	.037	.043	.028	.029	.028
Mean	.080	.084	.080	.065	.060	.048	.048	.042	.034	.038	.040	.038	.025	.030	.028	.043	.043	.056	.074	.067	.079	.084	.080	.076	.556

TABLE 8.—*Average hourly intensity of rainfall for 6-hour periods at Lincoln, Nebr.*

[Total hourly accumulated divided by number of times rain is recorded during the hour]

Month	Midnight to 6 a. m.	6 a. m. to noon	Noon to 6 p. m.	6 p. m. to midnight
May	0.051	0.026	0.034	0.058
June	.066	.041	.034	.092
July	.069	.053	.052	.110
August	.116	.050	.028	.103
September	.084	.047	.047	.067
October	.030	.022	.030	.031
Mean	.069	.040	0.38	.077

HOURLY PRECIPITATION AT TOPEKA, KANS.

S. D. FLORA, Meteorologist

[Weather Bureau Offices, Topeka, Kans., February 16, 1924]

To a person acquainted with the peculiarities of the climate of the Middle West and, especially eastern Kansas, where three-fourths of the year's moisture falls in the six summer months and is largely the result of thundershowers, it is a surprise to find that the hour with the heaviest fall of moisture is near sunrise, and the one with the least from noon to 1 p. m. This condition prevails at all times of the year, but is most pronounced in the summer season, which is also the thunderstorm season.

Thundershowers are chiefly the result of great upward rushes of air, due to overheating of the layer near the surface of the earth on warm afternoons, and this cause would naturally be less near sunrise, yet the graph shows

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Outdoor gatherings of all kinds, baseball games, picnics, and fairs, depend for their success chiefly on the absence of rain during the afternoon, and this distribution at Topeka has proved peculiarly favorable to them. The growing practice among managers of the more important events to insure against rainfall at specified hours, usually between noon and 6 p. m., has caused a closer study to be made of its distribution through the day, which has been one of the motives in this compilation.

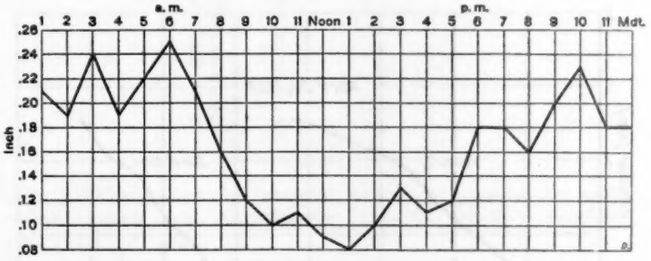

FIG. 1—Average hourly percipitation, Topeka, Kans., April to September, inclusive, for the period 1905–1923

The hourly records of precipitation at Topeka, like those at other Weather Bureau stations of the first order established more than 19 years ago, have been carefully compiled since the use of station Form No. 1014 was begun January 1, 1905. The means in the table that accompanies this article were obtained from this 19 years' record at Topeka. A few discrepancies have resulted in the record of winter months from moisture which fell

[1] Cf. Kincer, J. B. Daytime and nighttime precipitation. MO. WEA. REV., 44: 628–633.

in the form of snow and could not be recorded by the self-registering gauge, as rain has been recorded. In most instances the accumulated hourly amounts of precipitation that fell as snow have been credited to the hours ending 7 a. m. and 7 p. m.—the regular observation hours—with the result that the means for those hours are abnormally high for the winter months. To a less extent accumulated amounts have been credited to the hour ending at midnight, which has caused a slight rise in the mean for that hour. This trouble does not appear in the records for the warm months of the year, May to September, inclusive, and is seen to but a small extent in the records for April and October.

TABLE 1.—*Average hourly precipitation at Topeka, Kans., 1905–1923*

[Inches and hundredths]

Month	A. M.												P. M.											
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Midnight
January	0.02	0.01	0.02	0.03	0.02	0.03	0.13	0.02	0.02	0.01	0.02	0.03	0.02	0.01	0.02	0.03	0.02	0.04	0.12	0.03	0.03	0.03	0.04	0.08
February	0.04	0.05	0.02	0.06	0.05	0.04	0.11	0.04	0.03	0.07	0.05	0.07	0.08	0.05	0.04	0.03	0.05	0.08	0.28	0.02	0.04	0.04	0.07	0.11
March	0.08	0.09	0.06	0.07	0.06	0.04	0.19	0.05	0.03	0.05	0.05	0.06	0.04	0.09	0.10	0.08	0.10	0.09	0.19	0.10	0.09	0.12	0.21	0.25
April	0.17	0.11	0.16	0.10	0.09	0.10	0.19	0.12	0.07	0.06	0.06	0.08	0.08	0.05	0.07	0.08	0.12	0.07	0.18	0.09	0.11	0.08	0.12	0.15
May	0.15	0.22	0.25	0.16	0.24	0.27	0.22	0.20	0.12	0.13	0.19	0.13	0.11	0.24	0.15	0.14	0.16	0.13	0.18	0.21	0.26	0.24	0.13	0.15
June	0.18	0.14	0.28	0.23	0.34	0.21	0.14	0.12	0.12	0.16	0.12	0.13	0.08	0.11	0.10	0.10	0.09	0.21	0.28	0.26	0.28	0.26	0.22	0.14
July	0.32	0.30	0.32	0.20	0.16	0.33	0.18	0.09	0.08	0.05	0.05	0.01	0.05	0.10	0.13	0.16	0.18	0.24	0.13	0.08	0.17	0.22	0.21	0.21
August	0.16	0.15	0.22	0.24	0.18	0.34	0.24	0.18	0.08	0.08	0.15	0.06	0.06	0.07	0.09	0.04	0.12	0.25	0.17	0.20	0.25	0.18	0.21	0.21
September	0.30	0.26	0.21	0.21	0.34	0.27	0.28	0.26	0.22	0.14	0.10	0.12	0.08	0.05	0.23	0.13	0.08	0.15	0.11	0.10	0.16	0.41	0.22	0.18
October	0.10	0.11	0.07	0.12	0.19	0.09	0.07	0.10	0.11	0.08	0.07	0.06	0.07	0.10	0.09	0.09	0.08	0.08	0.14	0.11	0.17	0.12	0.10	0.19
November	0.10	0.07	0.08	0.10	0.07	0.04	0.10	0.04	0.02	0.07	0.08	0.03	0.06	0.06	0.09	0.06	0.12	0.13	0.13	0.07	0.06	0.08	0.09	0.12
December	0.01	0.01	0.03	0.04	0.01	0.02	0.11	0.03	0.04	0.04	0.02	0.03	0.02	0.02	0.03	0.06	0.06	0.05	0.15	0.04	0.03	0.03	0.04	0.08
Entire period	0.14	0.13	0.14	0.13	0.15	0.15	0.16	0.10	0.08	0.08	0.08	0.07	0.06	0.08	0.10	0.08	0.10	0.13	0.17	0.11	0.14	0.15	0.14	0.16
April to September, inclusive	0.21	0.19	0.24	0.19	0.22	0.25	0.21	0.16	0.12	0.10	0.11	0.09	0.08	0.10	0.13	0.11	0.12	0.18	0.18	0.16	0.20	0.23	0.18	0.18

THUNDERSTORM AT MEMPHIS, TENN., APRIL 29, 1924

By A. R. LONG, Observer

[Weather Bureau, Memphis, Tenn., May 10, 1924]

The weather map on the morning of April 29 showed an area of low pressure of considerable intensity central over Oklahoma. On the morning of April 30 it was central over the lower Ohio Valley. Numerous thunderstorms occurred on the eastern and southern sides of this low-pressure area.

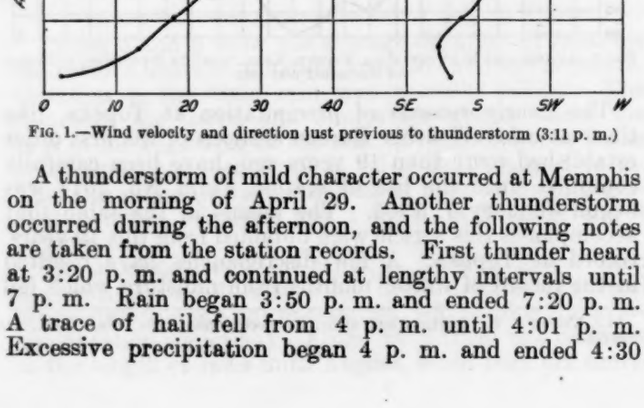

FIG. 1.—Wind velocity and direction just previous to thunderstorm (3:11 p. m.)

A thunderstorm of mild character occurred at Memphis on the morning of April 29. Another thunderstorm occurred during the afternoon, and the following notes are taken from the station records. First thunder heard at 3:20 p. m. and continued at lengthy intervals until 7 p. m. Rain began 3:50 p. m. and ended 7:20 p. m. A trace of hail fell from 4 p. m. until 4:01 p. m. Excessive precipitation began 4 p. m. and ended 4:30 p. m. A maximum wind velocity of 52 miles and an extreme velocity of 64 miles per hour from the northwest occurred at 3:57 p. m.

A peculiar feature of this storm can best be described as a large whirlwind cutting a path about 30 feet wide. It was first noticed on the Arkansas side of the river, where part of a large tree was blown down about 3:55 p. m. Moving from a WNW. direction across the river, it carried spray from the surface of the water spirally upward in a counterclockwise direction to the base of the low-lying clouds. The clouds at this point were very turbulent and moving rapidly from the WNW. In its passage across Wolf River, to the east of and parallel to the Mississippi River, it seemed to disturb the houseboats in its path more than the other houseboats on either side. Several windows were broken out of the Fall Building, situated upon the bluff about 500 feet from Wolf River and in the path of this disturbance, while adjoining buildings on both sides escaped undamaged. Branches were broken off of a number of trees and a few windows broken at several other places in the city, but no serious damage was reported.

FROST ON THE CRANBERRY BOGS OF NEW JERSEY

By GEORGE S. BLISS, Meteorologist

[Weather Bureau Office, Philadelphia, Pa., January 26, 1924]

The Weather Bureau has studied frost conditions on the cranberry bogs for many years, partly for the purpose of improving the forecasts and effecting greater savings thereby, and partly because of the interesting meteorological problems that the conditions present.

In 1906 and 1907 Prof. Henry J. Cox, of the Chicago station, made an exhaustive study of these conditions on the Wisconsin bogs, and the results were published as Bulletin T, W. B. No. 443. In 1917 Mr. C. A. Donnel spent the fall season at Whitesbog, N. J., and studied the physical conditions, but did not carry his studies far enough to work out any conclusive results.

In the fall of 1921 the Weather Bureau began a series of temperature and humidity observations at Whitesbog, under the supervision of the writer, for the purpose of obtaining data from which to compute a radiation formula (i. e., an equation from which to compute the minimum to which the radiation will carry the temperature during the night) for use in forecasting bog minimum temperatures. The fall series of observations was made

by Mr. C. C. Hamme, and the following spring series by Mr. Charles I. Dague. The results were analyzed and published in the MONTHLY WEATHER REVIEW for October, 1922.

This analysis showed that it would be necessary to have a greater number of observations before a reliable working formula could be computed. The results, however, were decidedly encouraging, for they gave assurance that a good radiation formula could be depended upon for more accurate results than had been possible by any other means yet tried. Clearly, too, such a formula could be employed by the grower to give him fairly dependable information, a desirable self-aid when he is not in touch with a Weather Bureau Office.

The application of a radiation formula requires very careful and accurate observational work in order to reduce errors to a minimum. It is advisable to take three sets of thermometer readings at each observation, and to use that set that gives the lowest dew point.

The Weather Bureau did not have funds to continue the observations at Whitesbog, and in the fall of 1922 the work was obligingly taken over by Mr. Charles S. Beckwith, special cranberry agent for the State of New Jersey. When Mr. Beckwith finished the series of observations last autumn we then had data for a total of 76 good radiation nights with the bog minima 40° or lower.

When the first analysis of the observations was made, and published in the MONTHLY WEATHER REVIEW, there were data for only 25 good radiation nights, and the writer was inclined to favor a straight-line formula that was computed by the method of least squares. A study of the larger number of observations now available has revealed the fact that such a formula is not flexible enough, or, in other words, does not have latitude enough, to cover the somewhat freakish conditions that are sometimes experienced on the bogs. The type of formula used by Mr. Floyd D. Young in California is better, because it employs variables that may be computed to fit the conditions. These observations also show that there is a decided difference between the radiation conditions of spring and of fall, hence it has been necessary to compute two sets of variables in order to cover this difference.

The formula which has been used by Mr. Young is as follows:

$$T = D - \frac{H-25}{4} + V - V'$$

in which T is the prospective bog minimum temperature; D the p. m. dewpoint; H the p. m. relative humidity; V a variable depending upon the dewpoint; and V' a variable depending upon the humidity.

The values given in Table 1 have been computed in accordance with the temperature and humidity conditions recorded on the 76 nights before mentioned, and they are no doubt very close to the results that we might expect if data were available from a much larger number of observations.

Application of the formula with the values of Table 1 to the conditions on the 76 nights before mentioned gives the results shown in Table 2.

With the most careful observational work possible, we may expect an occasional difference of as much as 3° between the actual and the computed dewpoint, and it will be noted that on 60 of the 76 nights, or approximately 80 per cent of the time, the difference between the observed and the computed minimum temperatures does not exceed that amount. Therefore the formula may be considered as about 80 per cent correct.

It is believed that this formula and the values as tabulated will apply with equal accuracy to all of the bogs in New Jersey with the possible exception of those nearest to the coast. For bogs in other latitudes, such as Cape Cod, or in Wisconsin, it would no doubt be necessary to compute a different set, or sets, of values to use in the minimum temperature equation.

TABLE 1.—*Computed values of V and V′ in the radiation equation* $(T = D - \frac{H-25}{4} + V - V')$

SPRING VALUES

Dew-point	V	Humidity	V'
°F.		Per cent	
25–27	3	25–40	0
28–30	2	41–52	−1
31	1	53–59	−2
32	0	60–66	−3
33–34	−1	67–71	−4
35–36	−2	72–76	−5
37–38	−3	77–81	−6
39–40	−4	82–86	−7
41–42	−5	87 up	−8
43–44	−6		
45–46	−7		
47–48	−8		
49–50	−9		
51–52	−10		
53–54	−11		
55	−12		
56–57	−13		
58	−14		
59–60	−15		
61	−16		
62–63	−17		
64	−18		
65–66	−19		
67	−20		
68	−21		

FALL VALUES

Dew-point	V	Humidity	V'
°F.		Per cent	
20–24	0	25–40	1
25–29	−1	41–52	0
30	−2	53–57	−1
31	−3	58–62	−2
32	−4	63–67	−3
33–34	−5	68–71	−4
35–37	−6	72–76	−5
38–40	−7	77–81	−6
41–43	−8	82–86	−7
44–46	−9	87 up	−8
47–50	−10		
51–53	−11		
54–55	−12		
56–57	−13		
58–59	−14		
60	−15		
61–62	−16		
63	−17		
64–65	−18		
66	−19		

TABLE 2.—*Comparisons of observed minimum temperatures with values forecast from computations from the radiation equation* $(T = D - \frac{H-25}{4} + V - V')$

SPRING SERIES

Date	Temperature, p. m.	Relative humidity p. m.	Dew point, p. m.	Forecast bog minimum	Actual bog minimum	Error
1922	°F.	Per cent	°F.	°F.	°F.	°F.
May 8–9	62	26	27	29.8	31.0	−1.2
10–11	67	65	54	36.0	39.5	−3.5
12–13	53	71	43	29.5	28.7	+0.8
15–16	59	78	52	34.8	33.7	+1.1
16–17	52	77	45	31.0	31.3	−0.3
19–20	63	50	44	32.8	38.5	−5.7
23–24	59	82	54	35.8	38.5	−2.7
24–25	61	60	46	33.3	35.8	−2.5
27–28	50	82	45	30.8	28.8	+2.0
28–29	55	64	42	30.3	30.3	±0.0
29–30	66	55	49	34.5	34.5	±0.0
30–31	63	78	55	35.8	37.2	−1.4
June 12–13	65	38	39	31.8	33.0	−1.1
13–14	54	81	48	32.0	39.4	−7.4
14–15	61	73	52	35.0	35.1	−0.1

TABLE 2.—*Comparisons of observed minimum temperatures with values forecast from computations from the radiation equation* $(T=D-\frac{H-25}{4}+V-V')$—Continued

SPRING SERIES—Continued

Date	Temperature, p. m.	Relative humidity p. m.	Dew point, p. m.	Forecast bog minimum	Actual bog minimum	Error
1923	°F.	Per cent	°F.	°F.	°F.	°F.
May 1- 2	63	37	36	31.0	28.0	+3.0
2- 3	59	52	41	30.3	32.2	−1.9
3- 4	60	50	41	30.8	30.2	+0.6
4- 5	69	50	50	35.8	35.2	+0.6
6- 7	62	62	48	33.8	33.0	+0.8
10-11	53	50	34	27.8	23.4	+4.4
13-14	65	56	49	34.3	32.0	+2.3
14-15	61	35	33	29.8	31.5	−1.7
22-23	68	50	49	34.8	34.5	+0.3
23-24	65	48	45	33.3	28.5	+4.8
24-25	60	34	32	29.8	30.0	−0.2
25-26	76	38	48	36.8	37.6	−0.8
26-27	80	41	54	40.0	40.3	−0.3
27-28	66	59	51	34.5	36.5	−2.0
31-June 1	62	81	56	35.0	33.1	+1.9
June 9-10	68	76	60	37.3	35.5	+1.8
10-11	75	66	63	38.8	41.1	−2.3
29-30	72	85	68	39.0	37.0	+2.0

Average error, −0.4°.

FALL SERIES

1921						
Sept. 22-23	81	79	57	36.5	42.0	−5.5
23-24	82	80	59	37.3	31.5	+5.8
24-25	76	93	52	32.0	40.0	−8.0
25-26	81	91	68	40.5	38.0	+2.5
26-27	74	92	47	28.3	29.8	−1.5
30-Oct. 1	86	92	55	34.3	29.0	+5.3
Oct. 1- 2	69	84	45	28.3	29.3	−1.0
3- 4	65	94	61	35.8	34.0	+1.8
4- 5	64	85	40	25.0	29.4	−4.4
6- 7	70	76	45	28.3	29.8	−1.5
8- 9	48	80	38	23.3	22.0	+1.3
9-10	60	87	38	23.5	29.0	−5.5
10-11	76	83	52	33.5	32.0	+1.5
12-13	56	77	37	24.0	22.0	+2.0
13-14	54	89	32	20.0	18.9	+1.1
14-15	70	96	39	22.3	21.4	+0.9
1922						
Sept. 22-23	60	72	51	33.3	36.2	−2.9
25-26	54	54	37	24.8	25.0	−0.2
26-27	52	78	45	28.8	28.1	+0.7
27-28	61	89	58	36.0	38.7	−2.7
Oct. 12-13	53	52	36	23.3	29.5	−6.2
13-14	52	62	39	24.8	27.1	−2.3
17-18	64	59	50	33.5	31.0	+2.5
18-19	50	48	30	22.3	20.0	+2.3
19-20	40	68	30	21.3	24.0	−2.7
24-25	34	81	29	20.0	22.5	−2.5
26-27	40	53	26	19.0	16.5	+2.5
1923						
Sept. 10-11	64	70	54	34.8	34.5	+0.3
11-12	64	82	58	36.8	39.5	−2.7
14-15	52	63	40	26.5	27.5	−1.0
15-16	54	73	45	29.0	29.5	−0.5
16-17	54	59	40	26.5	26.0	+0.5
17-18	55	65	43	28.0	28.0	±0.0
29-30	70	72	61	38.3	36.0	+2.3
Oct. 1- 2	56	65	44	28.0	31.0	−3.0
2- 3	61	65	49	32.0	34.0	−2.0
3- 4	56	65	44	28.0	33.0	−5.0
4- 5	65	52	47	30.3	22.5	+7.8
5- 6	45	78	38	23.8	24.0	−0.2
6- 7	44	78	37	23.8	15.5	+8.3
7- 8	45	86	41	24.8	20.3	+4.5
8- 9	47	69	37	24.0	20.0	+4.0
9-10	46	77	38	24.0	23.0	+1.0

Average error, −0.6°.

WEATHER DURING APRIL 21–26, 1924, AND THE FREE-BALLOON FLIGHTS OF APRIL 23–25

By V. E. JAKL, Meteorologist

[Weather Bureau, Washington, May 24, 1924]

The sequence of weather conditions over the country during the period of April 21–26, of more than passing interest in themselves, is of additional interest in view of the free-balloon flights of April 23–25, and their meteorological significance. An account of the national balloon race of 1924 and of the participation of the Weather Bureau in furnishing the pilots with all possible information before and during the flights, is given in the following extract from the report of Mr. J. H. Jarboe, official in charge of the Weather Bureau station at San Antonio, Tex.:

Seven balloons started from San Antonio, Tex., during the late afternoon of April 23, 1924, competing for distance in the national elimination balloon race. No records were broken, but four balloons exceeded a thousand miles, and the average mileage for the seven contestants was 798. The general course taken by all balloons was somewhat east of north, and closely coincided with the surface isobars, but the rapid and continuous movement of the balloons northward was quite unusual. Thunderstorms were encountered by all pilots as the balloons neared the center of low pressure, the first balloon being forced down 16 hours 46 minutes after the start.

Six of the balloons were equipped with radio sets, and the pilots received weather forecasts during their flight. Their logs show that messages came in from numbers of stations, some reaching as far eastward as New York the first night.

A rather comprehensive schedule for supplying meteorological information was conducted. Weather maps, forecasts, and upper-air conditions from Weather Bureau and Army aerological stations were supplied in bulletin form, and pilot-balloon runs were made hourly at the field by the Army meteorological detachment. The contestants were well informed of current and expected weather development before leaving the ground, and ample provision was made for supplying this information by radiophone during the race. Pilots were keenly interested in this feature, taking with them weather maps, forecasts, reported wind velocity aloft, and a schedule of broadcasting stations. The distance covered, time in the air, and the approximate location of the place landed are shown herewith:

Pilot	Duration H.	M.	S.	Miles	Landed (near)
Van Orman	44	4	44.6	1,072	Rochester, Minn.
Honeywell	39	11	0	1,042	Sanborn, Minn.
Peek	32	27	15	1,021	St. Ansgar, Iowa.
Thaden	34	8	26.2	1,003	Dubuque, Iowa.
Hill	25	20	20	565	Moline, Kans.
Fournier	18	7	32	517	Kaw City, Okla.
McKinley	16	46	0	365	Wapanucka, Okla.

The balloons started off with a surface wind of 12 to 14 miles per hour from the southeast. They traveled at altitudes of 200 to 400 meters, but increased their altitudes during the night and were soon making 30 to 35 miles an hour. Air currents at an altitude of 500 to 1,500 meters were used for the larger part of the race, the balloons traveling so rapidly at times that the pilots experienced difficulty estimating their positions.

Weather conditions and forecasts indicated that the balloons were being drawn into the center of the LOW while crossing Kansas, and altitudes up to and above 5,000 meters were used. Snow and freezing temperatures were encountered in the higher levels, as well as physical discomfort due to altitude. On the morning of April 25 four balloons were still in the air above northern Iowa and southern Minnesota, with the center of the LOW south of them. Thunderstorms and adverse winds on this date brought the race to a close, and the victory to W. T. Van Orman.

The week opened with an elongated LOW central over Missouri, attended by precipitation over its northern portion. This LOW was displaced the following morning (22d) by a weak HIGH, the LOW meanwhile passing off northeastward with increasing area of precipitation. By the morning of the 23d, the HIGH had increased in extent and depth and was overlying practically all the eastern half of the country. Coincidently with the development of this HIGH, scattered areas of low pressure in the west later merged into a well-marked trough that covered the western half of the country by the morning of the 23d, the major axis of the trough extending about NE. to SW. over the plateau region.

This distribution of pressure on the 23d indicated general south to north movement of air over middle sections of the country, the low and high areas being separated by approximately straight isobars extending from the Gulf to Canada. Wind conditions were therefore favorable for distance flights from San Antonio, as, following the gradient winds at moderate altitudes, the

balloons would necessarily drift in a general northerly direction. From the evidence of aerological observations, no other course gave as good promise of attaining distance from the starting point. The winds observed at about the time the balloons took off were steady southerly, becoming southwesterly at 2,000 meters, from Texas north to North Dakota. Velocities in the southerly current averaged about 30 miles an hour, being highest about 1,000 meters above the ground, and higher over northern sections than in the south. Over the Mississippi Valley and sections to the east the winds were lighter and more variable in direction, with a tendency to westerly in the higher altitudes. Over the Atlantic States the winds aloft had mostly a northerly component.

The same general drift prevailed on the 24th, except that the winds were south to higher altitudes over the eastern portion of the Plains States, and steadier and stronger south in the lower altitudes over the Mississippi Valley, the western trough of low pressure having developed in intensity and advanced farther east during the preceding 24 hours. Over the Eastern States no strong winds of definite general direction were observed except over the lower Lake region and thence eastward, where strong westerly winds were reported above about 1,000 meters. However, these westerly winds were not accessible to the pilots, as the southerly drift had carried the balloons only as far north as the lower Missouri Valley by the evening of the 24th. During the night of the 24-25th, the balloons that were still in the air made fairly good progress over Iowa, two penetrating into Minnesota by the morning of the 25th.

The wind conditions, substantially as outlined, were radioed to the pilots during the progress of the race in a series of bulletins given to broadcast stations that were successively within easy range of the balloons. Successful reception of these messages is attested to by the experience of Mr. W. T. Van Orman, the winner of the race, from whose report the following remarks are quoted:

> The stations from which our balloon, the *Goodyear Third*, received reports are as follows: WOAI, San Antonio; WBAP, Fort Worth; WMC, Memphis; KSD, St. Louis, KDKA, Pittsburgh. These reports were extremely valuable to us in our flight. You might be interested to know that in addition to these stations we arranged with and received weather reports from the following stations (naming 11 other stations) * * * We are inclosing a sample of the report which we requested these stations to broadcast, and in the majority of cases we found that their reports came out in this form.
>
> It is our opinion that the distance made in this recent race was made possible to a very large degree through the cooperation of the Weather Bureau and the various broadcasting stations. In conclusion, I might say it would be well in all subsequent races to arrange for broadcasting of the reports on a very much broader scale, as their value has been definitely proven in this contest. Please accept my most sincere thanks for the cooperation of the Weather Bureau given us in the recent contest.

Sporadic thunderstorms on the front of the trough over Oklahoma and Kansas forced some of the balloons down on the 24th, the remainder having been able to continue in the air until they reached Iowa and southern Minnesota on the morning of the 25th. Further progress was impossible, as by this time showers and thunderstorms were of general occurrence or impending throughout the upper Mississippi Valley and western Lake region. It is to the credit of the intrepid pilots and their aids that they were able to attain the distances they did in view of the threatening weather conditions they had to contend with on the 24th and 25th. The winner of the race lacked only about 100 miles of equaling the American record for distance. The paths followed by the two leaders in the balloon race and that of the Army balloon are shown in Figure 1.

Simultaneously with the start of the national balloon race an Army balloon, Lieut. James T. Neely, pilot, carrying C. Le Roy Meisinger, of the Weather Bureau, as meteorological observer, took off independently from Scott Field, Belleville, Ill., in one of a series of constant-elevation flights. This balloon, after drifting northward about 400 miles, was compelled to land in Wisconsin on the morning of the 24th for reasons similar to those that ended the balloon race in Iowa and Minnesota on the 25th. Threatening weather and variable winds developed in the night of the 23d–24th in the northeastern sector of the low-pressure trough, which on the morning of the 24th extended from Arizona and New Mexico northeastward to the Dakotas and Minnesota. Over this sector the observed easterly winds in the lower levels evidently became southwesterly at higher altitudes, as observations on the 24th and 25th within the low-pressure area indicated a wind structure characteristic of troughs, i. e., winds aloft of southerly component extending well beyond the rear and north of the center.[1] Observations at Ellendale and Denver on the 24th showed south to southwest winds aloft to 5,000 meters above winds in the lower levels that were northeast and west, respectively, and at Madison strong southwesterly winds aloft above surface winds that were becoming easterly. Drexel, on the 25th, showed a north surface wind, changing at about 300 meters altitude to south and southeast winds that extended to over 3,000 meters altitude.

In the lower levels over the region of Wisconsin and Minnesota the transition from southerly to easterly winds apparently occurred within a small latitudinal distance, the Army balloon having been carried in the last laps of its journey on the 24th in an arc of short radius (approximately shown in Fig. 1) from a southwest to an easterly wind. This is also well indicated in the opposing surface wind directions in the northeastern sector of the trough shown on the weather maps of the 24th and 25th. Reproductions of the weather maps showing the pressure distribution near the beginning and ending of the balloon race and at the time of landing of the Army balloon are given in Figures 1 to 3.

Following up the development of this low-pressure trough it will be noted that on the 26th the main center was over Iowa, with major axis trending NW. to SE. and general precipitation during the preceding 24 hours reported within its confines. A LOW with a NW. to SE. orientation of major axis, while of frequent occurrence,[3] is nevertheless abnormal, inasmuch as usually the trend of a trough of low pressure tends to become NE. to SW.[4] A closer study is therefore suggested of the general antecedent conditions, already briefly outlined in the earlier part of this paper. It will be noted that the HIGH, first faintly evident over the upper Missouri Valley on the p. m. map of the 21st, had evidently been gradually reinforced from the north. After it had attained its maximum depth and extent over the Eastern States on the 23d, another HIGH appeared, approaching from Ontario, which continued to develop and advance southward until on the 26th it was dominant over northeastern sections of the country, with highest pressure still over Ontario. Concurrently, pressure rose over the Pacific to a maximum on the 23d, followed by a decline on the 26th, and a rise in pressure over the Canadian mainland (see Northern Hemisphere map, not reproduced). An accompaniment of this pressure cycle was the advance south-

[1] See footnote 10, MO. WEATHER REV., January, 1924, 52:21.
[3] Of numerous examples, the weather maps of Apr. 28, 1918, Apr. 21, 1923, and Apr. 17, 1924, show well-defined types.
[4] See footnote 2, MO. WEATHER REV., February, 1924, 52:101.

eastward of an area of high pressure and lower temperature over the Rocky Mountain States on the 24th–26th, which, occurring simultaneously with the development of the Ontario HIGH, had the effect of segregating the northern portion of the low-pressure into the configuration observed on the 26th.

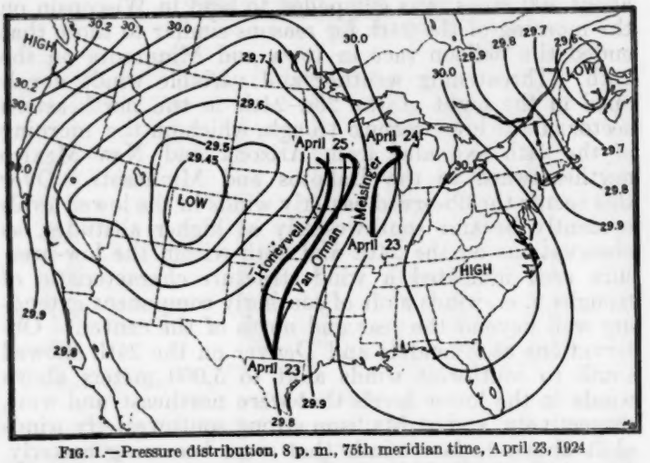

FIG. 1.—Pressure distribution, 8 p. m., 75th meridian time, April 23, 1924

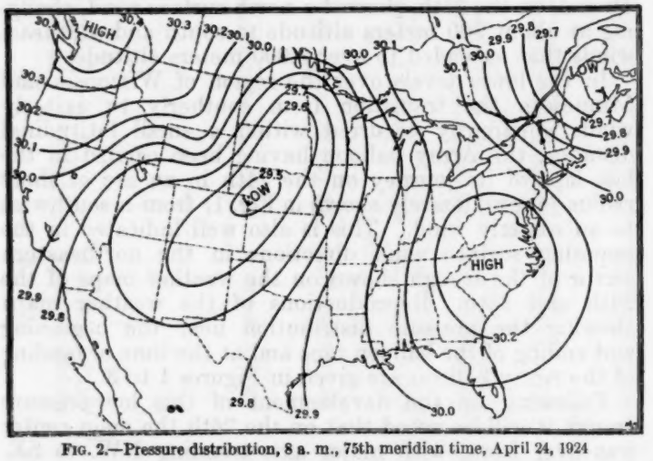

FIG. 2.—Pressure distribution, 8 a. m., 75th meridian time, April 24, 1924

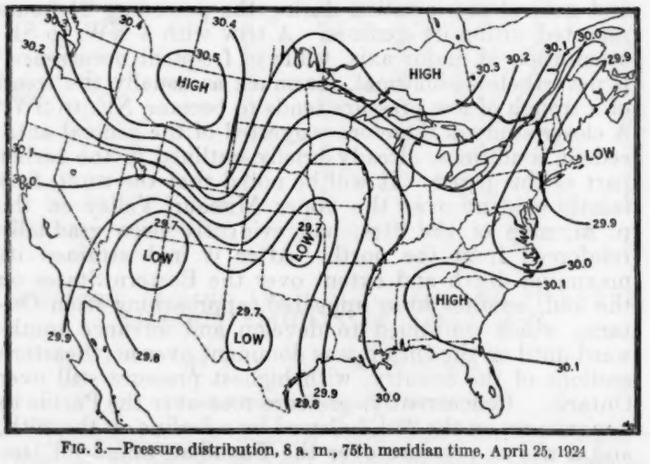

FIG. 3.—Pressure distribution, 8 a. m., 75th meridian time, April 25, 1924

An observation of SSE. wind aloft at 4,000 meters over Drexel on the 25th and at 4,500 meters over Ellendale on the 27th leads to the inference that a normal west-to-east movement of the detached LOW was prevented by the persistency of the Ontario HIGH, of which the SSE. winds aloft were a consequence. A close examination of the isobars on the weather maps from p. m. of the 24th to p. m. of the 26th shows that there was a retardation of the northern limb of the low-pressure trough in the region of the Dakotas and Minnesota during this period that amounted actually to a slight retrogression on the 26th. Further confirmation of this is given by the surface-wind record at Ellendale, where the wind changed from southerly to northerly on the 24th, and veered back to southeasterly on the 26th. It is noteworthy that precipitation did not occur at Ellendale until the wind veered from northwest to directions ranging from north through east to southeast, and that at Drexel precipitation was delayed nearly 20 hours after the wind had changed from south to northwest, and about 8 hours after it had begun at Ellendale. The significance of this is that the precipitation that occurred in the rear of the trough on the 25th and 26th can not all be attributed to the under-running effect of the cold high-pressure area from the northwest. Over southern sections only was it plausibly due to this cause. Over most of the Dakotas and Nebraska it seems more reasonable, from the foregoing facts, that precipitation was due to processes connected with the transport of air from around in front of the LOW.[5] The distinction between the two types of precipitation is often evident by a gap in the shaded area in the rear of the LOW, as is apparent on the a. m. weather map of the 25th.

In connection with the precipitation that occurred east of the low-pressure area, it is interesting to note the changes in temperature that occurred with changing configuration of isobars and, consequently, sources of supply of air. On the 24th at Drexel the temperature was 14.1° C. at 2,000 meters in a SSW. wind; and at Ellendale 15.2° C. at 2,000 meters in a southeast wind, and 6.8° C. at 3,000 meters in a south wind. At Royal Center the temperature was 7.2° C. at 2,000 meters in an east wind on the 26th; and on the 27th, 6.2° C. at 2,000 meters in a SSE. wind, and 1.0° C. at 3,000 meters in a southwest wind. The lower temperatures at Royal Center than at corresponding levels at stations to the west and northwest a few days previously were undoubtedly due to the difference in the source of air. On the 24th the air aloft over Drexel and Ellendale was supplied by the drainage extending far to the south and southwest, in paths approximating the course taken by the balloons. At Royal Center the winds in the lower levels on the 26th and 27th had their origin in the HIGH to the east, while the southwest wind observed at 3,000 meters on the 27th can be traced back in a curved path to the cold HIGH that appeared in the northwest on the 24th. Rain began at Royal Center on the 27th as soon as the wind near the ground changed from easterly to a more southerly component, indicating the building up of an adiabatic gradient between the warm southerly currents near the ground and the cold southwest wind aloft.[6]

NEW STANDARDS OF ANEMOMETRY

S. P. FERGUSSON and R. N. COVERT

With the approval of the Chief of the Weather Bureau, the authors, in 1921, began a redetermination of the rate of the standard anemometer extending to higher velocities than any attained in earlier tests of the instrument. This work was made possible by the generous cooperation of the aerodynamical laboratory of the Bureau of Standards in providing and operating the two wind tunnels in which

[5] MO. WEATHER REV., January, 1924, 52: 21 (par. (c)).
[6] MO. WEATHER REV., January, 1924, 52: 20 (3d par., 2d. column).

the instruments were tested. During the study of the standard anemometer, Dr. J. Patterson, of the Canadian Meteorological Office, published an investigation showing that a Robinson anemometer having three cups is better than one with four or more; trials of two instruments of this type confirming Patterson's conclusions, our investigation was extended to include the development of a new standard, the design or plan of which should be based upon the most recent studies and accumulated experience. Between April, 1922, and June, 1923, 38 anemometers of different kinds, proportions, and dimensions were tested in the tunnels and on a whirling machine and compared in the natural wind; many of these were modified temporarily to ascertain differences of rate, in steady and variable winds or due to variable friction, etc. In all, including a large number recently studied by Patterson and by Brazier, of France, there are now available measurements and rates of about 100 anemometers, including probably all patterns likely to be needed. From these there has been selected a new standard whose proportions and dimensions were decided upon after conferences with Doctor Patterson and others interested, during which was considered the desirability of a uniform international standard. The same type of anemometer with the same rating has been approved for use in Canada.

In advance of publication of the complete investigation, which will occur at an early date, and in order that the new standards of measurement may come into use as soon as possible, the authors present herein a table of correct values for velocities indicated by the old standard throughout the range of the natural wind, and comparisons of old and new values of the rate and of the old and new instruments.

TABLE 1.—*Correct or true velocities corresponding to velocities indicated by the standard four-cup Robinson anemometer of the Weather Bureau*

[In miles an hour]

Indicated velocity	0	1	2	3	4	5	6	7	8	9
0			2.2	3.2	4.2	5.1	6.0	6.9	7.8	8.6
[1] 10	9.3	10.2	11.2	12.0	12.8	13.5	14.3	15.0	15.7	16.5
20	17.3	18.1	18.9	19.7	20.5	21.3	22.0	22.7	23.4	24.2
30	24.9	25.7	26.4	27.2	28.0	28.7	29.4	30.2	30.9	31.6
[2] 40	32.3	33.1	33.8	34.5	35.2	36.0	36.8	37.5	38.2	38.9
50	39.7	40.5	41.3	42.0	42.7	43.4	44.1	44.9	45.6	46.3
60	47.0	47.8	48.6	49.2	50.0	50.7	51.5	52.2	52.9	53.7
70	54.4	55.1	55.8	56.5	57.2	58.0	58.7	59.4	60.1	60.9
80	61.7	62.4	63.1	63.8	64.5	65.3	66.1	66.9	67.6	68.3
[3] 90	69.1	69.8	70.5	71.3	72.1	72.9	73.6	74.3	75.0	75.7
100	76.5	77.2	78.0	78.7	79.4	80.2	80.9	81.6	82.3	83.1
[4] 110	83.8	84.5	85.2	85.9	86.7	87.5	88.3	89.0	89.7	90.5
120	91.3	92.0	92.7	93.5	94.2	95.0	95.8	96.4	97.1	97.9
130	98.7	99.5	100.2	101.0	101.8	102.6	103.3	104.0	104.7	105.4
140	106.2	107.0	107.8	108.6	109.3	110.1	110.8	111.5	112.2	113.0
150	133.8	114.5	115.2	115.9	116.6	117.4	118.2	119.0	119.7	120.5
160	121.3	122.0	122.7	123.4	124.1	124.8	125.5	126.3	127.1	127.8
170	128.5	129.2	129.9	130.7	131.5	132.3	133.0	133.8	134.5	135.2
[5] 180	135.9	136.6	137.3	138.1	138.9	139.6	140.3	141.1	141.8	142.5
190	143.3	144.0	144.7	145.5	146.2	146.9	147.7	148.4	149.2	149.9
200	150.7									

[1] Average velocity in the United States.
[2] Average standard of gale. Highest standard velocity by whirling machine in 1890, 35 miles an hour.
[3] Average standard of hurricane. Highest velocity by whirling machine in 1913, 67 miles an hour.
[4] Highest velocity usually recorded at exposed stations.
[5] Highest wind at the earth's surface, 186 miles an hour (indicated) on Mount Washington, January, 1876. Highest standard velocity in wind tunnel, 1922, 61 meters a second, or 137 miles an hour.

Tenths of miles or meters in this and the tables following are used only to obtain smooth values and are of no importance in correcting velocities for the reason that two similar instruments exposed near each other will sometimes disagree 5 to 10 per cent or more.

These new values indicate that the rate of the old standard determined in wind tunnels is nearer constant than the rate ascertained previously by means of whirling machines, but a comparison with the table of true velocities published in 1890[7] shows that the differences between the two are small.

TABLE 2.—*Comparative dimensions and proportions of old and new anemometers*

	Old standard (1860(?)–1924)	New standard (1924)
Diameter of cups	4 inches (102 mm.)	5 inches (127 mm.).
Length of arms	6.72 inches (170.3 mm.)	6.29 inches (159.7 mm.).
Original factor	3	2.50.
Factor for average velocities	2.65	2.50.
Value of 1 rotation:		
Factor 3	10.56 feet (3.22 meters)	9.84 feet (3 meters).
Factor 2.65	8.92 feet (2.72 meters)	
Factor 2.50		8.20 feet (2.50 meters).
Number of rotations of cups for 1 mile of wind:		
Factor 3	500	535.
Factor 2.65	568	
Factor 2.50		642.
Number of rotations of cups for 1 kilometer of wind:		
Factor 3	311	333.
Factor 2.65	353	
Factor 2.50		400.

The mechanisms of the old and new instruments are so nearly alike that the former can be altered to indicate true velocities by equipping it with the cups, spindle, and one gear of the new pattern, at a smaller cost than that of an entirely new anemometer. The dimensions and proportions of the new pattern are such that registration in any scale desired—kilometers, meters, miles, feet, or sixtieths of miles—can be accomplished by simple changes in the wheel work.

TABLE 3.—*True or correct velocities corresponding to velocities indicated by new standard*

In meters a second			In miles an hour		
Indicated	True	Remarks	Indicated	True	Remarks
2	2.1		5	5.1	
5	5.0	Average in America	10	10.0	Average in America.
10	9.8		20	19.6	
15	14.6	Gale.	30	29.1	Gale.
20	19.3		40	38.7	
25	24.0		60	57.8	Hurricane.
30	28.7	Hurricane.	80	76.5	
35	33.4		100	95.2	
40	38.3		120	114.8	
45	43.0		140	134.5	Highest recorded.
50	47.6		160	153.0	
55	52.3		180	172.6	
60	57.1	Highest recorded.	200	191.6	

TABLE 4.—*True velocities corresponding to velocities indicated by old and new standards when the instruments are adjusted to record correctly at average velocities*

IN ENGLISH UNITS

	Miles an hour										
Indicated velocity	5	10	20	30	40	50	60	70	80	90	100
Old standard, factor 2.65	5	10	19	28	37	46	55	64	73	82	91
New standard, factor 2.50	5	10	20	29	39	48	58	67	77	86	95

IN INTERNATIONAL UNITS

	Meters a second										
Indicated velocity	2	5	10	15	20	25	30	35	40	45	50
Old standard, factor 2.65	2	5	9	14	18	23	27	31	35	40	44
New standard, factor 2.50	2	5	10	15	19	24	29	33	38	43	48

The preceding comparisons show that differences between the old and new standards are unimportant or inconspicuous at low or average velocities, but increase at high velocities. When the factor 3 is used, gales of 25 miles an hour or higher indicated by the old standard are

[7] Circular D, second edition, p. 16.

about 22 per cent too high, and when the instrument is adjusted to record correctly at the most frequent or average velocities, by changing the factor to 2.65, its rate is still 6 per cent too high at 25 miles an hour and 9 per cent too high at 100 miles an hour. Velocities indicated by the new standard are about 2 per cent too high at 25 miles an hour and 5 per cent too high at 100 miles an hour; as indicated in the Table 4, when the old standard is properly adjusted and indicates a velocity of 50, the true velocity is 46; when the new standard indicates 50 miles an hour, the true velocity is 48, etc.

It is expected that the new standard will be adopted as soon as instruments now in use can be modified and replaced. A description, including plans of the new anemometer, is in preparation for use by anyone interested in the operation or manufacture of these instruments.

WHY HARDWOODS DO NOT GROW NATURALLY IN THE WEST

By J. A. LARSEN, Forest Examiner

[Excerpts from *The Idaho Forester*, annual, 1922, 4: 28-32]

Unfortunately the beautiful hardwood trees which are native to the Eastern States do not grow naturally in the West. We have here only aspen, cottonwood, small birch, hawthorns, cherry, and alder. On the Pacific coast are oak and maple, but limited largely to lower moist sites such as streams bed and canyons. The general absence of broad leaf trees in the West is most likely due to the difference in precipitation and temperature between the East and West. To be sure, there are other factors which limit the distribution of trees, such as soil acidity, alkalinity, soil and atmospheric moisture, as well as inherent qualities in the plants themselves. Soil acidity and soil moisture or quality of the soil can at best be of significance only within a limited area, and since it has been shown, except for areas near the sea, that atmospheric moisture varies according to the precipitation, it is only a result and, as such, not a controlling factor. Internal structure of leaves and stems, ability to transport much water, injuries by frost, etc., must be looked upon as direct results of the plant's environment rather than factors which control their distribution. There remains, therefore, the factors of temperature and precipitation and the variation and extremes of these worthy of consideration.

Air temperature, though it may not in all cases be a controlling factor, often limits the distribution of trees either by too short, too cold summer weather and frosts during the growing season, or by too great extremes. Experiments have shown that the leaves of trees do not become green in temperatures above 104° F. and do not function below 40° F. Unusually low temperatures may cause root killing, bark and wood splitting, and killing of buds and stems of hardwood.

If the growing season is too short, the species which are introduced from a warmer climate bud out too early in the spring, or have no time to form sufficient wood in the new stems to withstand frost injuries in the fall. If the nights are too cold throughout the summer months, one of the plant foods, sugar, which is not injured by freezing, has not had time to form before the cold weather sets in. The plant food is therefore chiefly in the form of starch, which is damaged by frost.

From the standpoint of water requirement of trees, it is well to note that the structure of the leaves, stems, and wood of trees may render some entirely unsuitable for certain climates, especially in regions characterized by dry summer air and low rainfall. Deciduous trees are able to transport much more water than conifers. Dr. Franz R. von Hohnel, of the Austrian Forest Experiment Station, determined by careful tests over a period of 12 years that 1 acre of oak forest lost by transpiration from 2,227 to 2,672 gallons of water per day during periods of growth. This is equal to 2.9 to 3.9 inches of rainfall per month for the growing season—much more than occurs over the western sections of the United States. Other broad-leaved trees are much like oak in respect to evaporation of water.

An examination of the distribution of hardwoods in the Eastern States shows that their general northern limit follows a line through St. Paul, Minn., to Eau Claire and Sheboygan, Wis.; Grand Rapids, Lansing, and Detroit, Mich. North of this line the forest is predominantly coniferous. From Detroit to central New York an inversion occurs in that the hardwoods are on the north and the conifers to the south. This is evidently due to low land and relatively warm air surrounding the Lakes and the higher land with colder air to the south. From central New York the line goes northeast through western Massachusetts, through Concord, N. H., and Augusta, Me., with conifers on the north and hardwoods to the south. The westward extension of the hardwoods is defined by the Mississippi River from St. Paul to Rock Island, Ill., thence southwestward through Iowa, Kansas, and Oklahoma, irregularly, according to local variations in topography.

In conclusion it may be said that precipitation and atmospheric moisture over the western United States are insufficient for the eastern hardwoods. Air temperature is suitable in most towns and cities and over extensive farming sections. This makes it possible by irrigation or by planting in certain very favorable sites such as moist slopes and aspects sheltered from the driving summer winds, to raise eastern hardwoods in the Pacific Northwest. Except for southern Idaho and the Pacific coast cities, however, the frequent frost which occurs over most of the region during late spring and early fall are a serious drawback, which stunts and kills back the young trees and retards growth on the mature trees.

[Charts showing the mean air temperature and rainfall for different eastern and western cities accompany the article showing the distinction spoken of in the test.]

TEMPERATURE SUMMATIONS WITH REFERENCE TO PLANT LIFE

By G. A. PEARSON, Director

[Fort Valley Forest Experiment Station]

Plant investigators are seeking an index of temperature which is expressive of the heat conditions required by plants. The mean temperature generally employed by meteorologists and too often by biologists is misleading when applied in the vegetable world. Plants are far less concerned with the relatively low night temperatures than with the more effective temperatures prevailing during the hours of daylight. For this reason a mean which gives equal wieght to night and day temperatures is a poor measure of the heat available for maintaining the physiological processes involved in plant life. The inadequacy of mean temperature is very evident in the mountain forests of the Southwest, where an extremely high daily range is the rule and where the native vegetation experiences little discomfort from low night temperatures even to the point of frost, but is exceedingly dependent upon heat energy for carrying on photosynthesis.

During a period of three years a series of meteorological stations in the vertical was maintained in the San Francisco Mountains of northern Arizona. The lowest of these stations was in the woodland or piñon-juniper belt at about 6,500 feet elevation. From here on up the mountain slope, one or more sets of instruments were installed; in the yellow-pine forest 7,300 feet; in the Douglas-fir forest at 8,700 feet; in the Engelmann-spruce forest at 10,500 feet; and finally near the upper limit of tree growth at 11,500 feet. Figure 1 shows decided irregularity in the graphs of mean temperature. This is particularly evident in comparing the graphs for the yellow-pine and the Douglas-fir forest. The Douglas-fir station, situated 1,400 feet above the yellow-pine station, gave a mean annual temperature only 0.7° F. lower than that of the latter. From December 1 to June 30, the monthly means for Douglas fir were often as high or higher than the corresponding records for yellow pine. In January the Engelmann-spruce forest, situated nearly 3,000 feet above the yellow pine, recorded the same mean temperature as the latter.

A glance at the mean minimum graphs shows at once that this is the source of disturbance. During every month of the year the yellow-pine station has a lower mean minimum than the Douglas fir, and in 8 months out of 12 it is below the Engelmann spruce. This phenomenon, which is well understood by meteorologists, is due to drainage of cold air off the mountain slopes and settling at the base where the yellow-pine station is situated.

Turning to the graphs (fig. 1) of mean maximum temperature, we find almost perfect coordination between the various stations. The days are invariably warmest in the lower altitudes. Here also we find the plants known to have high heat requirements. In every way the mean maximum temperature seems to furnish a reliable expression of heat relations in the various forest types. Throughout Arizona and New Mexico, wherever high mountain records are available, the same relative conditions have been found. When dealing with mean and mean minimum temperatures, inversions are the rule at stations situated on plateaus or in valleys at the base of high mountains; but inversions disappear in the mean maximum. The foregoing observations have led the writer to regard the mean maximum as a far better index of temperature than the mean, when plant life is under consideration. It is gratifying to find that the more recent summaries published by the Weather Bureau include the mean maximum temperature.

Various schemes have been devised to express in a single figure the total amount of heat available for plant growth during the growing season. One of the earliest attempts was that of Merriam, who, assuming that no appreciable activity in plants takes place when the mean daily temperature is below 43° F., added together the degrees of mean daily temperature above this minimum. Some of the obvious objections to this method are: (1) That the minimum temperature for growth varies greatly in different plants; (2) that growth is not directly proportional to temperature, and (3) that the computations are based upon mean daily temperature which has been shown in this paper to be a very uncertain quantity.

Where thermograph records are available it is possible to determine the mean temperature for each hour of the day and thus make an accurate summation of effective temperature according to any adopted standard. A simple though fairly effective method provides a means of analyzing temperature by merely adding together for each day the number of hours with temperature between any fixed limits. Thus it was found that in the spruce forest of the San Francisco Mountains the temperature curve rose above 70° F. only during four hours in the entire growing season (June–September) of 1918; during the same period the number of hours above 70° F. was 134 in the Douglas-fir forest and 633 in the yellow-pine forest. A decided improvement on this method could be attained by taking the product of intensity and duration, or what amounts to the same thing, by planimetering the space described by the thermograph curve and any fixed temperature line.

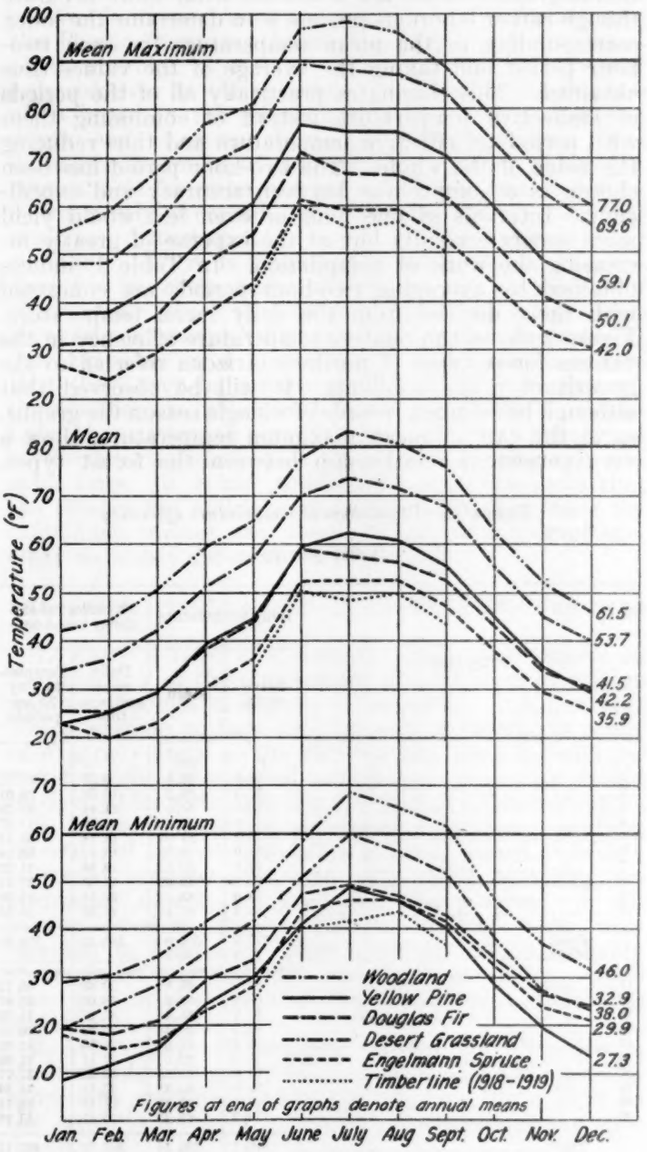

FIG. 1.—Temperature by forest types in northern Arizona

A marked advance over the foregoing schemes is made by what is known as the method of physiological indices of temperature efficiency. It is based upon experiments by Lehenbauer, in which he determined the hourly rate of growth of maize seedlings exposed to the same temperature during periods of 12 hours. The values thus obtained formed the basis for a table giving an index of efficiency for each degree in the centigrade scale. Livingston has worked out the corresponding values for the Fahrenheit scale. Taking the efficiency at 40° F. as

unity, it rises rapidly with temperature until a maximum of 122 is attained at 89° F., beyond which point the values decline.

Proper application of this method calls for a better measure of temperature than is afforded by the daily mean. Lehenbauer's experiment was conducted with plants exposed to constant temperatures. The index of efficiency corresponding to a given daily mean temperature may be far different from that obtained by summing the indices for the components of this mean. Where thermograph records are available, a far more accurate though rather laborious process is to determine the index corresponding to the mean temperature for each two-hour period and taking the average of the values thus obtained. This eliminates practically all of the periods of ineffective temperature instead of combining them with periods of effective temperature and thus reducing the value of the whole. The two-hour period has been chosen as a compromise between accuracy and expediency. Intervals of one hour or even less would yield more accurate results but at the expense of greatly increasing the work of compilation. In Table 1, indices obtained by averaging two-hour periods are compared with those derived from the daily mean temperature. Figure 2 shows the relative temperature efficiency in the various forest types of northern Arizona referred to the growth of maize seedlings. It will be observed that although based upon records of a single season the graphs, as in the case of mean maximum temperature, show a very consistent relationship between the forest types.

TABLE 1.—*Physiological temperature efficiency*

[Yellow-pine type]

June, 1918	Daily temperature		Physiological efficiency based on—	
	Maximum	Mean	Daily mean temperature	Temperature by 2-hour periods
	°F.	°F.		
1	68.8	52.8	9.22	17.22
2	75.5	54.2	10.33	28.01
3	75.7	56.5	14.44	31.23
4	77.0	56.3	12.78	37.97
5	76.2	57.05	14.44	38.73
6	79.0	58.45	16.11	39.04
7	77.7	60.25	19.88	41.22
8	77.5	59.65	19.88	37.47
9	83.0	63.25	27.11	51.50
10	86.3	67.15	41.33	56.97
Total	776.7	585.6	185.52	379.36
Mean	77.7	58.5		
11	88.9	68.85	50.83	66.12
12	88.2	68.0	46.00	45.87
13	81.9	66.4	37.22	44.29
14	81.2	65.45	33.33	40.56
15	76.6	61.95	24.33	31.22
16	76.9	62.5	27.11	31.99
17	81.0	66.25	37.22	37.77
18	79.0	63.35	27.11	34.54
19	78.0	63.45	27.11	31.71
20	79.0	63.35	27.11	43.10
Total	810.7	649.55	337.37	407.17
Mean	81.1	64.96		
21	77.8	66.15	37.22	28.80
22	70.0	61.15	22.00	21.00
23	73.5	62.75	27.11	28.65
24	77.6	61.4	32.00	33.47
25	81.0	64.75	33.33	44.46
26	86.3	67.4	41.33	61.48
27	86.5	70.5	60.33	68.45
28	86.8	65.7	37.22	55.90
29	83.5	66.25	37.22	42.95
30	82.1	64.05	30.00	36.46
Total	805.1	650.10	347.76	421.62
Mean	80.5	65.01		
Monthly total	2,392.5	1,885.25	870.65	1,208.15
Monthly mean	79.8	62.8		

Since plants vary in their heat requirements, indices of efficiency should be determined for each species concerned, or at least for several groups of species having approximately the same requirements. In forestry, for instance, separate determinations should be made for characteristic species such as western yellow pine, Douglas fir, and Engelmann spruce.

Of all the methods here described, the method of physiological indices is the only one which is based directly on the response of plants to heat. This method promises to be very useful when supported by thermograph records and experimental data on the response of various species. Without these data, however, the values obtained are only a rough index. Under these circumstances, which indeed are those generally encountered, the mean maximum temperature is believed to be the most practical index available. In the mountains of the Southwest it has proven far more consistent and expressive than mean temperature, and while it may not prove equally superior in regions of low daily range and higher temperatures generally, it will undoubtedly prove a valuable adjunct to records of mean temperature. As

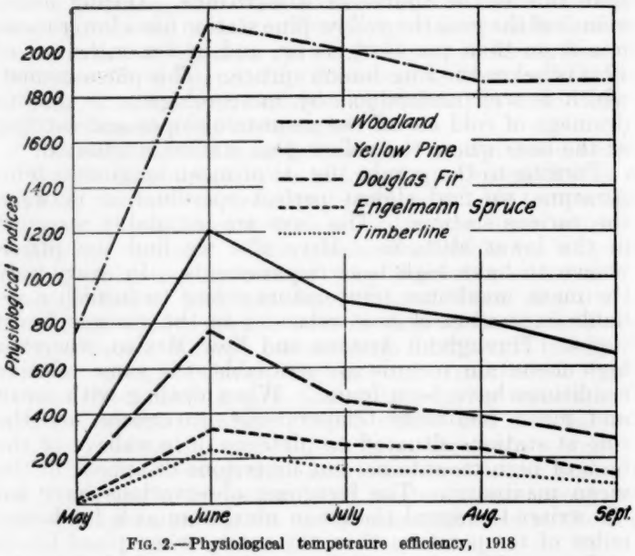

FIG. 2.—Physiological tempetraure efficiency, 1918

compared to the method of summing daily means above 43° F. or any other minimum limit, it has the advantage of greater simplicity and consistency.

In conclusion I wish to recommend to ecologists that they consider the mean maximum temperature where thermograph records are not to be had. Obviously, the mean maximum is to be regarded only as an index rather than a complete measure of heat conditions. To Weather Bureau officials I wish to suggest that they use every effort to include the mean maximum in their temperature summaries.

OUR PRESENT KNOWLEDGE CONCERNING THE ATMOSPHERIC DISTURBANCES OF RADIOTELEGRAPHY[1]

L. W. AUSTIN[2]

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Our present knowledge concerning the atmospheric disturbances of radiotelegraphy is very limited, but in the following I have attempted to make a brief résumé of the known facts and generally accepted hypotheses.

[1] Subreport of committee on atmospheric-electric phenomena and measurements in the troposphere and stratosphere presented at the annual meeting of the section of terrestrial magnetism and electricity of the American Geophysical Union, Apr. 18, 1923.

[2] Reprinted from Bull. of the National Research Council, vol. 7, pt. 5, No. 41. Washington, 1924, pp. 127–130.

Atmospheric disturbances, popularly called static, form the chief obstacle to the progress of radio telegraphy and telephony. They give rise to troublesome noises in the telephone receivers, which frequently make the reception of signals at great distances impossible, even in the case of the most powerful transmitting stations. They are generally most violent during the warmer months, and are especially severe in the Tropics. They differ in strength from year to year, and their intensity usually increases rapidly with the wave length to which the receiving apparatus is tuned.

The disturbances have been classified by Eccles according to their sound in the telephones as clicks, hissing, rumbling, and crashing.

The clicks and hissing are of comparatively little importance, the first being thought to be due to distant flashes of lightning and the second to the discharge of dust, snow, or rain, striking the antenna.

The rumbling type (grinders), which is the most common type of disturbance, is generally believed to consist of strongly damped electrical wave trains or of untuned single pulses. That this type of disturbance has sometimes a certain amount of tuning is shown by the fact that the individual discharges are not always heard simultaneously at different wave lengths, but it is believed that the discharges are so numerous that, since they occur at different frequencies, they form a kind of disturbance spectrum and thus appear in the receiving apparatus at every wave length to which the antenna may be tuned. While nothing is definitely known as to the exact nature of the source of the rumbling disturbances, it is believed that they are probably produced in the upper atmosphere by electrical readjustments. The resulting electrical waves expand in a more or less spherical manner until the lower portions of the wave front strike the earth, when they spread out, guided by the earth, and move off with a wave front which soon becomes practically vertical exactly like the electrical waves started from the transmitter of an airplane. The more powerful rumbling disturbances seem to come frequently from definite centers which often appear to lie above mountainous regions; for example, a large proportion of these disturbances which have been noted along the coast of Oregon and Washington appear to come from the direction of Mount Rainier. Other well-marked centers have been observed in the mountains back of San Francisco and San Diego. The centers mentioned appear to be nearly constant in position and have been continuously active since their first discovery in 1920. It is believed that there is also a center of great energy somewhere in southern Mexico which frequently produces receiving difficulties throughout the eastern United States, where disturbances from the Allegheny Mountains are also noticed. Among other reported sources of rumbling disturbances are large cities, perhaps on account of their ascending currents of heated air, thunderclouds, though here they are apparently unconnected with the visible lighting flashes, which produce clicks, and the advancing edges of rain areas. It may be said that, in general, the rumbling disturbances more commonly originate above the land, as ships far out at sea are comparatively little troubled by them.

The intensities of disturbances of the rumbling type seem to be closely connected with the seasonal variations in the height of the sun's path. Some observations in Africa, reported by Dr. R. B. Goldschmidt and R. Braillard, tend to show that radio stations close to the Equator have two well-marked maxima during the year at the time when the path of the sun passes through the zenith.

When the disturbances are directive and come from a direction different from that of the signal which is being received, it is often possible to eliminate a large part of the disturbances and thus improve the reception by making use of unidirectional receiving apparatus. Unfortunately it generally happens that there are secondary centers, such as local clouds or near-by mountains, which act upon the receiving station from several directions at the same time.

Some situations have been found, notably in California, where the disturbances come almost entirely from one point. In these places reception from the direction of the Pacific Ocean can be made nearly free from atmospheric troubles.

In addition to the rumbling disturbances, crashes are often heard in the telephones which seem to differ in origin and character from the rumbling type. The difference in sound of the two types is not easily distinguishable for untrained observers, since the rumbling is frequently preceded by a crashing noise. The true crashing disturbance, however, is not followed by rumbling. There is little evidence that the crashes are directive in character, while there are a number of observations which tend to show that they occur simultaneously at widely distant stations; for example, at San Francisco and Honolulu. It has been suggested that they may be connected with solar outbursts, although there is little direct proof to this effect. Sometimes they appear to occur in large number on days when earth-current disturbances are noted on telegraph and cable lines. It is also thought by radio operators that the crashes are entirely untuned in character, since the individual crashes are observed frequently simultaneously on widely different wave lengths.

THE CHIEF PROBLEMS OF ATMOSPHERIC DISTURBANCES

1. There is need of systematic daily observations on the intensity of the atmospheric disturbances at a large number of points in all parts of the earth. It is desirable where possible, to have this intensity measured in terms of electric voltage on the antenna expressed in volts per meter height. Eventually recording apparatus should be devised for automatically taking these observations.

2. Measurements are also needed on the prevailing direction of the directive types of disturbances at widely scattered stations. As soon as possible recording instruments should be used for this purpose. A direction recorder has, I believe, already been constructed in England. These observations will probably show daily and seasonal shifts of prevailing direction and will eventually indicate certain points as disturbance centers.

3. When these disturbance centers are identified, a study should be made of the meteorological and electrical conditions prevailing, which will perhaps throw light on the conditions under which the disturbances are produced.

4. Observations should be made on the simultaneity of individual disturbances at widely distant points, identifying as far as possible the type of disturbance.

5. The question of the directivity of the crashing type should be settled.

When sufficeint information regarding these points has been collected, comparisons can be made between the disturbances and other natural phenomena, solar activity, the earth's electrical and magnetic phenomena, and those of seismology and volcanology.

SEVERE WINTERS IN SOUTHERN GERMANY AND SWITZERLAND SINCE THE YEAR 1400 DETERMINED FROM SEVERE LAKE FREEZES[1]

By Dr. J. MAURER

[Translated by W. W. Reed, Weather Bureau, Washington]

Hellmann's well-known investigations of the behavior of certain seasons over long periods (severe and mild winters, warm and cool summers, etc.) will always be of great importance as meteorological histories of large and small areas, respectively; one of the last of these valuable works treats of severe winters at Berlin during the period from 1766 to 1917. It presents a series of significant results, which have been summarized in clearly arranged manner in the work, "*Über strenge Winter*" (*Sitzungberichte der Preussischen Akademie der Wissenschaften, Dezember 1917, Nr. LII*). As a criterion in determining severe winters, Hellmann employs the sums of the negative daily temperature means for the months from November to March.

At about the same time that Hellmann's work appeared, I sought to classify the severe winters for the rather limited region of southern Germany and Switzerland, extending the investigation as far as possible into the past. Reliable temperature records for the earlier centuries are, of course, not available; however, I could well take very unusual lake and river freezing as a criterion of winter severity. The extremely severe winters, when for months at a time everything was frozen solid and for weeks all of the large lakes north of the Alpine divide were frozen over so thick that heavy wagons could cross, are well remembered. We have a series of reliable weather records, made by well-qualified writers [2] dating far back into the fifteenth century. By critical examination of these we can determine the severe winters as indicated by unusual freezing of the lakes in southern Germany and Switzerland. In thus classifying the severe winters we avoid the known inaccuracies in old temperature records (due to instrumental error, method of exposure, etc.) which affect comparisons and often prove troublesome.

From the long duration of lake freezing in the severe winters of 1829–30, 1879–80, and 1890–91 we know very reliably that there must be a negative temperature total (November, December, and January) of at least 350° to 400° C. for the lakes to be entirely frozen over for weeks.[3] In the severest winters at Berlin from 1766 to 1917 the sums of the negative daily temperature means from November to March ranged from 683° to 321° C. In the data for northern Germany there appears very plainly a great climatic oscillation. In the period from 1788 to 1845 there was an unusually large number of severe winters, among these some of the most severe on record, while since that period the number of such winters has shown a marked decrease. In the 58 years from 1788 to 1845 Hellmann counts 17 very severe winters and in the 71 years from 1846 to 1917 only 6. In the past 60 years there has been a marked relative increase in the number of mild winters in northern Germany and also in southern Germany and Switzerland.

For the same period (from 1788 to 1845) the number of severe winters in southern Germany and Switzerland is found to be quite different—only 3 (1788–89, 1799, and 1829–30). From this it is seen how totally different conditions may be even in the limited region including Germany and Switzerland. The 89-year period of recurrence of cold winters in middle (and western) Europe found by Easton has, therefore, no claim to general validity; it does not take into consideration the conditions just mentioned.[4]

If we make a critical study of the reports on severe lake and river freezes, we find the following series of severe winters in south-central Europe since the year 1400:

Severe winters in south-central Europe

1400–1500	1500–1600	1600–1700	1700–1800	1800–1900
1407–8	1513–14	1599–1600	1708–9	1829–30
1434–35	1516–17	1608–9	1717–18	1879–80
1443–44	1550–51	1659–60	1737–40	1890–91
1460–61	1562–63	1683–84	1754–55	1894–95
1464–65	1564–65	1684–85	1762–63	----------
1468–69	1570–71	1694–95	1788–89	----------
1476–77	1572–73	----------	----------	----------
1490–91	1586–87	----------	----------	----------

Another grouping may be given as follows:

1435–1587	15 severe winters in 153 years.
1588–1680	4 severe winters in 92 years.
1681–1800	10 severe winters in 120 years.
1801–1923	4 severe winters in 123 years.

From 1770 to 1923, in a period of 154 years, we count only 6 severe winters in South Germany and Switzerland, while from 1788 to 1845, in a period of only 58 years, Hellmann notes 17 such winters in northern Germany.

The exceedingly small number of severe winters (4) in south-central Europe from 1800 to 1923 certainly permits the conclusion that an offsetting will follow in the coming century; of course it is difficult to predict in what year this will begin.

An interesting circumstance is to be mentioned here Since the past summer there has been extremely little activity on the surface of the sun. Evidently the sun-spot minimum is rapidly approaching; indeed, according to the data recorded by Professor Wolfer at Zurich, it has already arrived. From all investigation we have these facts: Well-defined epochs of least solar activity since 1610 are known from Wolfer's table, the last sun-spot minimum occurring in 1913. Since the year 1600 the surface of the sun has been seen in its state of minimum activity 28 times. During the appearance of these sun-spot minima for more than 300 years it has happened only once (in 1754–55) that a severe winter in south-central Europe coincided with the epoch of sun-spot minimum. A long, servere winter at this time (1923–24) would therefore certainly be an anomaly in our latitude.

The large number of mild winters and the small number of very cold winters in south-central Europe since 1800 indicates a kind of "climatic oscillation," whose cause lies completely hidden.

[1] Translated from *Meteorologische Zeitschrift, Band XLI, Heft 3* (March, 1924), by W. W. Reed, Washington, D. C., May 19, 1924.

[2] The third volume of "*Der Sammler in den Alpen*," by J. M. Schirmer, is a valuable, though not well-known, source of weather records. This manuscript contains a rich collection of interesting Swiss weather reports covering the period from 1600 to 1800.

[3] In the severe winter of 1879–80 the sum of the negative daily temperature means at Zurich was 400° C. for the period from Nov. 1 (?) to Jan. 22, when the lake was frozen over entirely; the number of *Frosttage*, days with mean temperature below 0 C., was 79 from Nov. 1 to Feb. 10. For the same winter Arnet gave the total of negative temperature means at Lucerne from November to the end of February as only 430° C. and the number of *Frosttage* as 76. In the long winter of 1890–91 the negative temperature total at Zurich was 365° C., with 56 *Frosttage* from November to Jan. 21, the date of freezing. The total of negative temperatures at Zurich from November to the end of February was 458° C., while at Lucerne that from Nov. 26 to Feb. 22 was 426° C. on 84 *Frosttage*. The thickness of the ice on the lower part of Lake Zurich was 6 cm. on Jan. 22 and 14 cm. on Jan. 30, 1891, while the river ice at the outlet had a thickness of 40 cm.

[4] W. Köppen, "*Eine 89 jahrige Periode in der Witterung*," *Meteorologische Zeitschrift, 1918, S. 98.*

NOTES, ABSTRACTS, AND REVIEWS

GAIN AND LOSS OF TIME WHEN FLYING WITH AND AGAINST THE WIND

By W. J. HUMPHREYS

It is natural, perhaps, at first thought, to imagine that the time of a round-trip flight over a straight course is the same, other things being equal, regardless of the velocity of the wind along that course. At any rate, many seem to think that the time gained by flying with the wind a given distance is exactly equal to the time lost by flying the same distance against a wind of equal strength.

This is an error, and though easily seen it may be worth while to get a simple general expression for the time gained when flying with the wind, the time lost when flying against it, and the difference between the two.

Let l be the length of the course in miles; w and s the strength of the wind and speed of the airplane in still air, respectively, in miles per hour.

Then, in terms of hours:

Time in still air $= l/s$.
Time with wind $= l/(s+w)$.
Time against wind $= l/(s-w)$.
Gain with wind $= l/s - l/(s+w) = lw/s(s+w)$.
Loss against wind $= l/(s-w) - l/s = lw/s(s-w)$.
Loss minus gain $= 2lw^2/s(s^2-w^2)$.

During equal intervals of time, however, the gain of distance with the wind is equal to its loss against the wind, and in each case is at the rate of w miles per hour.

Of course, all this is both obvious and old; nevertheless it may, perhaps, be a helpful hint to some who have not yet thought of everything that is obvious.

ON THE SEAT OF ACTIVITY IN THE UPPER AIR

By P. C. MAHALANOBIS

[Abstracted from *Memoirs of the Indian Meteorological Department*, Vol. XXIV, Pt. 1, Calcuta, 1923]

Dines and Shaw, upon the basis of relationships between surface and free-air pressures and other elements, as indicated by correlation coefficients, have reached the conclusion that the seat of origin of pressure changes lies in the substratosphere and the region above. Exner, Hesselberg, Köppen, Wedemayer, and C. K. M. Douglas have investigated the problem from the physical standpoint, and there is considerable controversy as to the validity of the conclusions that have been drawn. The author examines Dines's data from the statistical standpoint.

Dines infers that the pressure at the 9-kilometer level is the controlling variable, since the average numerical values of the correlation coefficients involving that factor are higher than those of any of the other variables. The author attacks the problem by attempting to determine the height at which the numerically greatest coefficients of correlation will occur.

Beginning with the hypsometric equation, the author arrives at the following identity:

$$B \equiv b/a = P_o Z / 29.3 T^2_z,$$

in which P_o is the pressure at sea-level, Z the length of the air column, and T_z the mean temperature of the air column up to the height z. Transforming his equations into expressions involving correlation coefficients, it is found that the value of Z may be determined from the equation above when appropriate values of B are used, and these appropriate values of B must make the sum of the coefficients a maximum. This leads to

$$B = s_1 (r_{12}R_1 - R_2)/s_2 (r_{12}R_2 - R_1),$$

the several factors being defined as follows:

s_1 and s_2 are the standard deviations of sea-level pressure and mean temperature of the air column from 1 mk. to 9 km.;

r_{12} is the correlation coefficient between sea-level pressure and the mean temperature from 1 km. to 9 km.;

R_1 is the sum of the coefficients of correlation between sea-level pressure and any other variable x_n; and

R_2 is the sum of the coefficients of correlation between mean temperature of the air column between 1 km. and 9 km., and any other variable x_n.

Now, using Dines's data and the last equation above, values of B are found, whence correlation coefficients may be computed between the pressure at z km. and the various elements, sea-level pressure, mean temperature of the air column, 1 km. to 9 km., pressure at 9 km., height of the stratosphere, and temperature of the stratosphere, for which Dines has given values using pressure at 9 km. instead of at z km. The author's "constructed" set gives a value 14.7 per cent higher than Dines's.

To get at the values of B appropriate to various heights for use in Southeast England, the author takes temperature data from *Geophysical Memoir No. 13*, and assumes P_o to be 1,014 mb., which, as will be seen from the first equation given above, will enable him to compute B for various heights, independent of Dines's coefficients. From values of B previously derived from Dines's coefficients, corresponding heights are calculated on the basis of the above temperature gradients and sea-level pressure. The result, based thus on Dines's data, indicates, in the author's words, "that the region from 2 to 4 km. is statistically more important than the region from 7 to 11 km. If statistical importance implies any causal or physicel significance, then the region from 2 to 4 km. seems to have better claims to be considered the seat of activity * * * than the substratosphere and the regions above."

The final portion of the paper is given to a brief discussion of Dines's treatment of partial correlation and partial regression coefficients of various orders in which several discrepancies between Dines's and the author's conclusions appear. This portion is not directly pertinent to the main discussion, hence will not be treated in abstract.—*C. L. M.*

ICE IN THE ARCTIC SEAS, 1923

[Reprinted from *Nature* London, May 3, 1924]

The Danish Meteorological Institute has published its well-known report on the state of the ice in the Arctic seas for 1923. In many respects the year was an exceptional one. In the Kara Sea conditions were unusually favorable, for not only the southern part ice-free in July, but also practically the whole sea was clear of ice in August and September, and probably much of October. The Barents Sea was unusually clear from April to the end of summer. In August there was open water to Franz Josef Land and the Wiche Islands and well to the north of Spitzbergen. Around Spitzbergen the ice conditions were also somewhat exceiptional. Bear Island was clear of pack by the end of April, and the west coast of Spitzbergen had no ice of significance from May until November. The north coast was so free from ice that Spitzbergen was circumnavigated with comparative ease. While reports from the east coast of Greenland were few, there is evidence that ice conditions in that region were bad and that the ice was packed closely against the coast. In spring and early summer there was an unusual quantity of ice on the Newfoundland banks, but in Davis Strait the ice was scarce. Scantiness of information from many Arctic seas necessarily detracts from the value of this annual record, but it represents the only systematic

collection of data relating to ice movements in which it may be possible in time to recognize some periodicity in occurrence.

RARE LUNAR HALO PHENOMENA

Mr. P. Connor, in charge of the United States Weather Bureau station at Kansas City, Mo., reports that at 8:20 p. m., April 16, 1924, a bright paraselene was observed on a segment of a 22° lunar halo for about 15 minutes. The colors presented by the paraselene varied from bright white to pink, the latter on the side next the moon. Between 2 and 3 a. m., on April 17, Mr. John Macy, of Woodston, Kans., observed a very bright paraselenic circle and the upper half of the 22° halo, together with bright 22° and 120° paraselenæ; neither the halo nor the paraselenic circle extended beyond their points of intersection; otherwise they were complete.

BALL LIGHTNING

The phenomenon of ball lightning is believed to have been observed by Mrs. R. V. Zimmerman at her home about 10 miles northeast of Charles City, Iowa, at 9 p. m. March 28, 1924. Mr. E. G. Larson, in charge of the Charles City Weather Bureau office, transmits Mrs. Zimmerman's account of the phenomenon, which is substantially as follows:

On Friday evening, March 28, about 9 o'clock, I saw in the southwest a light which at first was thought to be a reflection from the electric lights of Charles City, but it seemed brighter than those lights. After watching it for a time, I called my 14-year-old daughter and we agreed that it might be a fire. The fire, if it were such, would rise and fall, then suddenly it shifted to one side for as much as a rod and started to come toward the house; as it kept coming closer, I again called my daughter and she again confirmed my impression. By this time it was almost to our lane and moving slower; it stopped in the road just outside the lane for perhaps a minute and a half or two minutes. It appeared to be a globe of white light about the size of an ordinary lantern globe. The light from it was reflected perhaps 3 rods, and it seemed to rest about 2 or 3 feet above the ground. By this time we were both thoroughly frightened. As quickly as it had come it began to recede to where it was first seen. We watched it for a short time longer; it would come toward us a little way and then recede—*A. J. H.*

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING APRIL, 1924

By HERBERT H. KIMBALL, In Charge, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January and February, 1924, **53**: 42 and 113.

From Table 1 it is seen that solar radiation intensities averaged close to normal values for April at all three stations.

Table 2 shows that the total solar and sky radiation received on a horizontal surface averaged close to normal at Washington; below normal at Madison, and above normal at Lincoln.

Skylight polarization measurements made on 8 days at Washington give a mean of 58 per cent, with a maximum of 62 per cent on the 23d. Measurements obtained on 2 days at Madison give a mean of 64 per cent, with a maximum of 69 per cent on the 18th. These are slightly above the average April values at the respective stations.

TABLE 1.—*Solar radiation intensities during April, 1924*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.				P. M.					Local mean solar time
	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Apr. 2	2.74					1.41	1.09	0.80			2.87
3	3.45		0.61	0.80	1.01	1.33	1.20	0.98	0.75	0.54	2.74
5	5.36				1.01						5.79
7	3.81	0.75	0.83	0.93							3.81
8	4.57	0.67	0.80	0.98	1.13	1.41					3.45
11	3.63				0.96						3.45
19	4.37		0.60	0.75	0.99						4.57
21	3.99	0.73	0.86	1.01	1.18						8.48
22	9.47					1.40	1.18	0.90			3.30
23	3.81	0.69	0.80	0.96	1.16	1.39	0.74				3.63
24	4.75			0.77	0.96	1.34	0.96				5.79
25	7.04					1.39	1.16	0.99	0.82	0.71	4.57
26	4.75		0.71	0.85	1.11	1.35	1.11				4.17
Means		**0.71**	**0.74**	**0.88**	**1.06**	**1.38**	**1.06**	**0.92**	**(0.78)**	**(0.62)**	
Departures		**+0.01**	**−0.01**	**±0.00**	**−0.01**	**+0.02**	**−0.02**	**+0.02**	**+0.04**	**+0.03**	

TABLE 1.—*Solar radiation intensities during April, 1924*—Contd.

Madison, Wis.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.				P. M.					Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Apr. 2	2.74				1.29						3.99
9	4.17			1.20	1.34	1.49	1.33				4.37
10	3.45			1.03	1.21	1.52					3.63
18	4.75				1.28						3.45
23	5.36					1.25					5.79
29	6.76				1.15						6.76
Means				**(1.12)**	**1.25**	**1.42**	**(1.33)**				
Departures				**+0.03**	**+0.02**	**±0.00**	**+0.09**				

Lincoln, Nebr.

Apr. 1	2.26			1.17	1.32	1.51	1.24	1.07	0.94	0.84	2.87
2	4.17		0.69	0.98	1.20	1.52					5.56
7	5.56	0.64	0.73	0.94							6.27
9	3.63			1.13	1.28	1.52					2.62
14	9.83	0.77	0.88	1.03	1.21	1.44	1.12	0.93	0.78	0.65	8.18
15	9.83		0.88	1.02	1.18						9.14
17	3.81		0.77	1.03	1.31						2.06
18	4.17	0.86	0.97	1.18	1.33	1.51					3.00
22	3.81			0.89							3.63
23	4.37			0.65	0.87	1.29					7.57
24	11.38			0.82							12.68
28	6.02	0.71	0.79	0.95	1.13	1.40					7.57
30	6.02					1.40	1.24	1.07	0.93	0.83	3.81
Means		**0.74**	**0.82**	**0.98**	**1.20**	**1.45**	**1.20**	**1.02**	**0.88**	**0.77**	
Departures		**−0.02**	**−0.02**	**−0.02**	**−0.02**	**±0.00**	**+0.02**	**+0.05**	**+0.04**	**+0.07**	

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface.*

Week beginning—	Average daily radiation: Washington	Madison	Lincoln	Chicago	New York	Average daily departure from normal: Washington	Madison	Lincoln
1924	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Apr. 2	458	383	525	340	———	+67	+5	+88
9	381	479	560	335	———	−36	+86	+126
16	356	289	561	232	[1] 250	−67	−123	+120
23	560	301	424	237	506	+122	−132	−33
Excess or deficiency since first of year on Apr. 29						+1,410	−3,592	+846

[1] Six days only.

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The average pressure for the month did not differ materially from the normal at a number of land stations on the coasts and islands of the North Atlantic, as shown in the following table. The sea-level pressures are for 8 a. m., 75th meridian time, while the departures are only approximate, as the normals were taken from the Pilot Chart, and are based on observations at Greenwich mean noon, which corresponds to 7 a. m., 75th meridian time.

Station	Average pressure	Departure
	Inches	*Inches*
St. Johns, Newfoundland	29.79	−0.09
Nantucket	29.94	−0.04
Hatteras	30.04	±0.00
Key West	30.01	−0.01
New Orleans	30.02	+0.02
Swan Island	29.89	−0.09
Bermuda	30.08	+0.08
Horta, Azores	30.00	−0.12
Lerwick, Shetland Islands	29.79	−0.01
Valencia, Ireland	29.88	−0.01
London	29.87	±0.00

The number of days with winds of gale force was considerably greater than usual over the southern steamer lanes, between the 30th and 50th meridians. Over the remainder of the ocean approximately normal weather was the rule, with the exception of the waters adjacent to the European coast, where gales were rare, being reported on from 1 to 2 days only.

Judging from reports received from the greater part of the ocean, the number of days with fog did not differ materially from the normal, as shown on the Pilot Chart. In the Gulf of Mexico, however, fog was unusually frequent for that locality, being reported on 7 days; in the region between the Azores and Gibraltar it was observed on from 1 to 2 days.

On the 1st and 2d a moderate "norther" was reported from the Gulf of Mexico, accompanied by the comparatively high barometric readings usual in heavy winds of that character.

On the 2d there were also two well-developed cyclonic disturbances in northern waters; the first central between Portland and Nantucket, and the second near latitude 48° N., longitude 35° W., while moderate to strong gales swept the steamer lanes west of the 35th meridian. On the 3d the western LOW was over Newfoundland, and apparently continued in its northeasterly movement, although it was impossible to locate the position on the 4th, due to lack of observations. The second disturbance moved slowly in an east-southeasterly direction, moderating somewhat from day to day, and by the 5th the center was about 5° west of Lisbon, while on the 4th, northerly gales prevailed to the southward and eastward of the Azores. Storm logs:

American S. S. *Bibbco:*

Gale began on the 1st, wind W. Lowest barometer 29.80 inches at 11:30 p. m., on the 1st, wind W., 8, in latitude 37° 06′ N., longitude 68° 55′ W. End on the 2d, wind W. 9. Highest force of wind 9; shifts SW.–W.–SW.–W.

British S. S. *Kenbane Head:*

Gale began on the 2d, wind N. Lowest barometer 29.10 inches at 3 a. m. on the 2d, wind N. 10, in latitude 49° 40′ N., longitude 38° 50′ W. End on the 3d, wind N. Highest force of wind 10, N.; shifts N.–NNW.

American S. S. *Hera:*

Gale began on the 2d, wind NNW. Lowest barometer 29.95 inches at 11:45 p. m. on the 3d, wind NNW. 7, in latitude 39° 55′ N., longitude 27° 45′ W. End on the 5th, wind NNE. Highest force of wind 9, NNW.; shifts NNW.–NNE.

On the 7th a severe disturbance of limited extent was off the American coast between the 35th and 40th parallels, and the daily weather map of that date shows for New York a northwesterly wind of 52 miles an hour, and for Nantucket a southeasterly wind of 48 miles an hour, with rain. This LOW moved slowly eastward, developing its greatest intensity on the 10th, when near latitude 33° N., longitude 50° W.; on the 13th, while central about 5° west of Horta, Azores, it began to fill in and lose intensity. Storm log:

American S. S. *American Press:*

Gale began on the 10th, wind WSW. Lowest barometer 29.63 inches at 9 a. m., on the 10th, wind S. 10, in latitude 35° 30′ N., longitude 42° 55′ W. End on the 11th, wind NW. Highest force of wind 10; shifts S.–WSW.–SW.–NW.

On the 14th a moderate disturbance, limited in area, was central near latitude 35° N., longitude 45° W. This, moving eastward, was by the 15th in the vicinity of latitude 40° N., longitude 40° W., with moderate to strong easterly gales in the northerly quadrants. From the 15th on this LOW apparently decreased in force during its slow easterly drift.

On the 15th a second and much deeper depression was over Newfoundland; this also moved slowly eastward and on the 19th was somewhere in the vicinity of latitude 50° N., longitude 40° W. During this period gales were prevalent over the greater part of the ocean west of the twenty-fifth meridian, while hail and snow were reported by a number of vessels in this region. Storm log:

Dutch S. S. *Burgerdijk:*

Gale began on the 16th, wind NNW. 7. Lowest barometer 29.71 inches at 10 p. m. on the 18th, wind NNW. 8, in latitude 38° 37′ N., longitude 54° 33′ W. End on the 19th, wind NNW. 6. Highest force of wind 9; steady NNW.

On the 19th Portland, Me., was near the center of a depression that was remarkable for its regular easterly movement across the ocean. On the 27th this depression was off the coast of Great Britain. From the 19th to 21st gales of hurricane force were reported from a limited area over the western section of the ocean, as shown by the following storm log:

American S. S. *President Hayes:*

Gale began on the 19th, wind NW. Lowest barometer 29.17 inches at 2 a. m. on the 19th, wind SW., in latitude 39° 15′ N., longitude 58° W. End on the 21st, wind N. Highest force of wind 12, W.; shifts S.–NW.

Charts VIII to XIII cover the period from the 22d to 27th, inclusive, and show the progress of the above-mentioned disturbance between these dates.

The American S. S. *Iowan*, Captain Laverge, observer, J. B. Macomber, en route from San Pedro to New York, observed waterspouts on the 25th and 26th, as shown in the following report:

At 10 a. m. (apparent ship's time) on the 25th sighted large waterspout 1 mile off Cape Maysi, Cuba, very active. Ships position at 7 a. m. on the 25th, latitude 18° 31′ N., longitude 74° 56′ W.

At 6 a. m. on the 26th sighted large rain cloud over Castle Island, with large waterspout. Within 20 minutes there appeared seven spouts in one cloud, all large and very active. At sunrise they gradually disappeared and heavy rain fell on Castle Island and Fortune Island, while none fell on the ship, 1 mile from the latter island. Ship's position at 7 a. m., on the 26th, latitude 23° 16′ N., longitude 74° 20′ W.

On the 28th there was a deep depression central near latitude 48° N., longitude 35° W., which was apparently surrounded by moderate winds only. This increased in intensity during its easterly movement, and on the 29th winds of hurricane force were encountered in a limited area near the 50th parallel, between the 20th and 30th meridians. Storm log:

British S. S. *Michigan:*

Gale began on the 28th, wind WSW. Lowest barometer 29.29 inches at 11 p. m. on the 28th, wind WSW. 11, in latitude 50° 32′ N., longitude 27° 40′ W. End on the 30th, wind W. Highest force of wind 12; shifts SW.–WSW.–W.

On the 30th this LOW was over the British Islands and had begun to fill in. On the 30th there was a second disturbance central near latitude 45° N., longitude 40° W., and vessels in the southerly quadrants reported westerly gales of force 8–10. Storm log:

German S. S. *Albert Ballin:*

Gale began on the 29th, wind SSE. Lowest barometer 29.38 inches at 2 a. m. on the 30th, wind SW. 8, in latitude 44° 10′ N., longitude 37° 32′ W. End on the 30th, wind NW. Highest force of wind 11, W.; shifts SW.–WSW.–W.

SOUTH ATLANTIC OCEAN

By ALBERT J. MCCURDY, Jr.

Weather reports received from vessels that traversed the southern shipping routes in April, 1924, indicate that stormy conditions prevailed off the South American coast in the first and last decades of the month.

During the first of these periods three vessels encountered fresh to whole gales. These were the German S. S. *Bayern*, and the British steamships *Damerara* and *Gloria de Larrinaga*.

The *Damerara*, Capt. T. A. Hill, proceeding from Brazil toward Liverpool, on the 1st encountered a westerly gale accompanied by heavy rain squalls. Mr. A. Hambly, fifth officer, reports that the lowest pressure observed was 29.56 inches, this occurring at 2 p. m., in the River Plate. The wind at this time was WNW., force 8, thence shifted to W. by S., and increased to a strong gale. This gale ended on the 2d, wind W. by S. Highest force of wind 9.

On the 2d the *Bayern*, Capt. H. Molchin, proceeding from Hamburg to Buenos Aires, encountered the same gale while in 35° S., 54° W., reporting conditions similar to those experienced by the *Damerara*. Mr. K. Schubert, observer, states that the lowest barometer, 29.52 inches, was recorded at 4 a. m., on the 2d. The wind at this time was W. by S., force 11.

On the same date the *Gloria de Larrinaga*, Capt. J. J. Doyle, proceeding from Cardiff to Buenos Aires, came within its influence, experiencing west-northwesterly winds, force 8, accompanied by high seas. Mr. F. J. O'Hara, 2d officer, reported the lowest observed pressure, 29.67 inches, occurring in 32° S., 51° W. This gale ended on the 3d, wind SW. by S.

The Danish S. S. *Nevada*, Capt. K. R. Fischer, proceeding from Buenos Aires to Newport News, on April 26 encountered a westerly gale accompanied by heavy squalls and rain. Mr. K. K. Kjolhede, observer, states that the lowest pressure observed was 29.96 inches (uncorrected), occurring at 10 a. m., in 29° 16′ S., 47° 07′ W. The wind at this time was W., force 10. Similar conditions continued throughout the 27th.

103847—24†——3

NORTH PACIFIC OCEAN

By WILLIS E. HURD

During April there was a considerable decrease in storm intensity on the North Pacific over that of the preceding month. Many liners reported no storm winds whatever, while the majority of those vessels recording gales observed no forces exceeding 9. Occasionally a force of 10 indicated some increase in cyclonic or anticyclonic activity, and on one date, the 29th, a full hurricane wind of several hours' duration was encountered.

A considerable amount of precipitation occurred over some areas, noticeable in the Hawaiian and eastern tropical regions, and snow and sleet fell in higher latitudes on several scattered days throughout the month. Along the coast of the United States from San Francisco northward rainfall was deficient.

Apart from the prevalence of the Aleutian cyclone over the Gulf of Alaska, no cyclonic storms of much importance appeared in American coast waters. From the 14th to the 17th moderate gales occurred along these shores between the 40th parallel and Cape San Lucas, due to the considerable gradient between the eastern North Pacific high pressure area and a cyclone then central over the Western States.

On the 20th low pressure began forming on the eastern boundary of the HIGH, or near 35° N., 135° W., and on the 21st and 22d moved in upon the continent. This condition resulted in moderate to strong gales along the coasts of Washington, Oregon, and northern California from the 22d to the 24th. The maximum force recorded was 10 from the north on the 22d, experienced by the Norwegian S. S. *Ranenfjord* while steaming up the coast in latitude 40° 58′ N., longitude 124° 40′ W.

To the southward of Cape San Lucas the winds were for the most part light during April, calms and variables being frequent, but northwesterly winds being prevalent. Over and to the southward of the Gulf of Tehuantepec north to northwest gales of forces 8 to 9 were reported on the 17th, 18th, and 19th, accompanied by a slight fall in pressure.

The northeast trades prevailed in the Hawaiian region. Some slight depressions appeared in this area, and that of the 6th gave Honolulu a maximum wind velocity for five minutes of 48 miles an hour from the southwest, this breaking previous records for the month. This was the wettest April on record here, as well as the second cloudiest. On the 21st and 22d another depression entered the Hawaiian area. It, however, gave very little wind, but did produce an extraordinary downpour of rain which amounted to 7.99 inches at Honolulu during the two days. The depression had moved northward into the sphere of the Aleutian LOW by the 25th.

In the Far East a few continental LOWS entered upon the Pacific. One on the 1st to 3d from northern Japan caused moderate gales of forces 7 to 9 which were experienced by vessels to the eastward of the archipelago. A depression which left China near the 30th parallel on the 5th also caused moderate gales on that and the following day over neighboring waters and to the southward of Japan. No high winds from depressions of later date in this general region have been reported.

The Aleutian LOW, as a fluctuating storm area, was well defined almost throughout the month, with its center of activity lying east of the Alaska Peninsula

during an irregularly distributed two-thirds of the time and mostly over the northern part of the Gulf. For the other third of the period the center was over Bering Sea. Lows descended into western Canada from this region on the 1st, 5th, 11th, 15th, 17th, 20th, and 27th. The lowest observed land-station pressure for the month was 28.86 inches, at Kodiak on the 26th. The minimum recorded by a vessel at sea was 28.92 inches, on board the Japanese S. S. *Alaska Maru* in 44° 21′ N., 147° 13′ W., on the 29th. On the same date the American S. S. *Oduna*, in latitude 55° 51′ N., longitude 145° W., had a barometer reading of 28.97. These instances indicate the great extent of the area covered by very low pressure.

The eastern North Pacific HIGH was best established during the first 20 days of April. Thereafter it was considerably broken up, during the last five days largely by the southward swing of the Aleutian cyclone from the Gulf of Alaska.

Pressure at Dutch Harbor averaged 0.16 inch below normal during the first half of the month and 0.19 inch above during the last half. For the month (29 days) the average pressure, based on p. m. observations, was 29.86 inches, or 0.01 inch above normal. The highest pressure, 30.40, was recorded on the 17th and 20th; the lowest, 29.16, on the 3d. The average pressure at Midway Island was 30.11 inches, or 0.02 inch below normal. The highest reading, 30.30, was recorded on the 26th; the lowest, 29.86, on the 30th. At Honolulu pressure was continuously below normal from the 3d to the 23d, the average daily departure (p. m. observations) being −0.09 inch. The average pressure for the month was 30.01 inches, or 0.05 inch below normal. The highest reading, 30.14, was recorded on the 29th; the lowest, 29.85, on the 6th.

Aside from the storm conditions previously noticed, it is observed that a greater part of the northern steamship routes had more gales on the 1st, 2d, and 3d than on any other day or period of days during the month. These gales did not as a rule exceed 8 or 9 in force, but they were accompanied by frequent snow squalls in higher latitudes and raised high seas both east and west of the 180th meridian.

The American S. S. *West Cayote*, Capt. L. Johnson, bound from Portland toward Yokohama, encountered rougher weather probably than any other vessel making a trans-Pacific voyage in April. From the 1st to the 10th, or during most of the westward passage, she passed through a succession of westerly to northerly gales, which did not, however, exceed 9 in force. Her lowest observed pressure was 29.01 inches in 52° 17′ N., 163° 05′ W., on the 3d.

There was little storm activity reported for the greater body of the ocean from the 10th to the 25th. The maximum number of stormy days occurred over and to the southward of the Gulf of Alaska, as might be inferred from the greater prevalence there of the Aleutian cyclone, especially during the last week. This cyclone reached its peak of severity on the 29th, at which time the S. S. *Alaska Maru* experienced her lowest pressure, as already noted, and also sustained a west-southwesterly wind of hurricane force from 4 p. m. until midnight, near 44° N., 147° W. This was the only gale of the month, so far as known, to exceed 10 in force.

Fog, especially in east longitudes, along the sailing routes, showed a decided increase in percentage over that of March. It was observed along practically the entire China coast on the 10th, and in the neighborhood of Shanghai continued until the 16th. Fog also occurred on several days along the American coast, being noted from Puget Sound southward to near Acapulco.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

By ALFRED J. HENRY

A warm dry month on the Pacific coast, also warm in the great interior valleys; elsewhere the temperature was close to the normal. More than the normal precipitation in Atlantic coast States and in some of the Gulf States, also in the upper Mississippi Valley. See the inset on Chart IV. The usual details follow.

CYCLONES AND ANTICYCLONES

By W. P. DAY

The movement of the low-pressure areas during the month of April, 1924, was even more erratic than usual for a month which has long been characterized by halting, undecided, and abnormal storm movements. One storm, which developed over Nevada on the 22d, after moving eastward in the normal manner to northwestern Missouri, turned northward and northwestward and finally dissipated over northeastern Montana. In this case the air flow within the LOW was diverted by the intrusion to the east of a large area of high barometric pressure from the Hudson Bay region. A large number of the low-pressure areas had the so-called trough formation in which the point of lowest barometer is a rather indefinite and shifting phenomenon. One of the most severe storms of the month on the Atlantic coast suddenly developed in the southern end of one of these troughs during the 6th in the vicinity of the Virginia Capes, moved northeast to New England, and thence eastward into the Atlantic.

FREE-AIR SUMMARY

By V. E. JAKL, Meteorologist

The average free-air conditions over that portion of the country represented by aerological stations were practically normal in all respects. This is evidenced by Tables 1 and 2, from which it will be noted that the departures from the normal were slight for all elements, although there were a few exceptions. Such exceptions were plausibly accidental rather than real, owing to the circumstance of observation. As kite flights are dependent upon suitable wind and weather, observations by means of them can not be carried on even to moderate altidudes with the regularity characteristic of surface meteorological work. The scattered departures of apparently decided value noted in Tables 1 and 2 need not therefore merit other than passing notice.

Such slight temperature departures as recorded in the general averages are in close agreement geographically—also in character and amount—with the surface departures that appear on Chart III. Inferentially, the causes contributing to the observed average temperatures on the ground extended aloft to the upper limit of observation. For example, the principal periods of cool weather east of the Rocky Mountains, in so far as they are revealed in aerological records, occurred on the 1st–2d, 9th–10th, and 17th–18th. Kite flights made at stations

that were successively within the influence of the HIGHS of which these cool waves were attendant features invariably showed temperatures below normal throughout the vertical column of air sounded. This is in distinction to the common effect of cold-wave HIGHS of the winter months, which frequently, particularly in their earlier stages, cause marked falls in temperature in the lower levels only. Days with temperature above normal were not quite so well defined into periods, nor in scope of area covered by aerological stations, but in most cases the record of kite flights on warm days also showed parallel vertical temperature departure; i. e., a positive departure at all levels. The most conspicuous examples of abnormally warm winds of considerable depth and covering an extended area, are shown by the records of Broken Arrow, Drexel, and Ellendale, on the 15th and 24th. On both dates these stations were in the front of a well-defined trough of low pressure.

The month can be considered a normal one only from the standpoint of the average values as shown in the appended tables, inasmuch as there was frequently a marked tendency to rapid development of threatening weather. To this feature of the month, among other abnormalities in the sequence of weather conditions (see other sections of this REVIEW), can be attributed some observations made at a number of stations on scattered dates under rather unusual circumstances. At two stations, Ellendale and Royal Center, flights were made in threatening weather that resulted in portions of the steel kite line being destroyed by lightning or overcharge of static. The following extract is taken from the report of the Ellendale station: "On April 4, with six kites and 6,500 meters of wire out, a thunderstorm developed suddenly. As much speed as possible was made in reeling in, and it was not until we had reeled in to 3,500 meters that the lightning struck the wire. In this instance the kite wire was not fused, but only burned and distempered. This weakening of the wire was followed by a breakaway. The two men making this flight were standing near the reel, but not touching it, when the lightning struck." On this date Ellendale was in a position midway between a LOW to the southwest and a HIGH to the northeast, with winds that may be said to be appropriate to that position; i. e., the wind veered from east on the ground to southwest at 3,000 meters, and to west at the altitude of the A. St. clouds at 4,800 meters. The record shows that at first the temperature rose and fell irregularly from the ground to 1,700 meters, above which there was an unbroken lapse rate exceeding the adiabatic for saturated air, and a regular increase in humidity, the lowest temperature, and a humidity of nearly 100 per cent being recorded at 4,000 meters, the upper limit of observation. Later, or about the time the discharge took place, humidity had increased to 100 per cent throughout the column of air above about 2,000 meters, and St. Cu. clouds had developed. In this region, above 2,000 meters, convection evidently occurred causing precipitation which in turn caused the high electric charge, the previously dry air in this region needing only the bringing in of moisture to make the existing lapse rate effective to cause convection. No appreciable rain fell, however, until after the maximum temperature had been attained in the lower levels, and the inversions obliterated, after which the lapse rate was adiabatic or more down to the ground.

The following report from Royal Center tells of a somewhat similar experience at that station: "Lightning struck the kite wire on the 18th and vaporized 1,300 meters. No one was injured, except that the men on kite work complained of injury to their eyes, which was noticeable only several hours after the occurrence." In this instance, Royal Center was differently situated with respect to pressure distribution than was the case at Ellendale on the 4th; also the temperature conditions were different. The unstable condition causing the thunderstorm appeared to be due mainly to falling temperature aloft and sustained temperature below. On the date in question Royal Center was under the influence of a LOW central over Ontario. Temperatures aloft had fallen progressively since the 16th, until on the 18th they were much below normal at altitudes above 1,000 meters. The winds aloft were WSW., indicating the transport of cold air from the rear of the LOW, while SW. winds sustained the temperature near the ground. The circulation aloft had been effective in transporting the cold air from regions far to the west and northwest without material gain in temperature, as the preceding 30 hours' record showed temperatures only about 2° C. lower over Drexel and 5° C. lower over Ellendale than at corresponding levels over Royal Center on the 18th. From the following table it is apparent, both from the lapse rate and the humidity, that convection vigorous enough to cause thunderstorms was probably operative only below 2,800 meters, and that the actuating cause was the veering of the surface wind from SW. to WNW. and W. and the rise in pressure usually attending such change in direction.

Meteorological conditions over Royal Center, Ind., on April 18, 1924

Time	Altitude, meters	Temperature, °C.	$\frac{\Delta T}{100\ m.}$	Humidity, per cent	Wind direction	Wind velocity, m. p. s.
12:36	4,122	−16.2	0.57	41	WSW.	29
1:24	2,827	−8.8	.66	94	WSW.	17
1:55	1,249	1.6	.94	85	SW.	16
2:07	Surface	11.0		72	W.	7

A diurnal series of observations at Broken Arrow was interrupted on the night of the 28th–29th by the rapid development of the storm area that appeared central over Kansas on the morning of the 29th, and caused severe thunderstorms in its wake thence east to the coast. Some of the conditions attending the rear of the squall line of this storm are shown in the following table, which gives the upper-air temperatures and winds that prevailed soon after the squall line had passed Due West on the 30th:

Meteorological conditions over Due West, S. C., on April 30, 1924

Time	Altitude, m. s. l., meters	Temperature, °C.	Humidity, per cent	Wind direction	Wind velocity, m. p. s.
1:24	Surface	23.2	48	W.	18
1:31	651	17.4	57	W.	20
1:38	1,406	10.3	84	W.	16
1:59	1,976	5.7	90	WSW.	24
2:05	2,178	4.1	78	W.	27
2:06	2,274	7.3	49	W.	27
2:50	2,607	5.2	25	W.	24
3:10	2,621	4.5	29	W.	22
3:47	2,711	3.6	41	W.	21
4:22	2,738	0.5	49	W.	23
4:38	2,739	0.2	78	W.	22
5:10	2,018	4.4	93	W.	19
5:29	1,385	9.7	93	W.	19
5:44	716	16.4	58	W.	17
5:50	Surface	21.4	52	W.	10

A severe squall occurred at Due West and tornadoes elsewhere in South Carolina a short time before this observation was taken. While it will be noted that the temperature aloft was falling with time, and the lapse rate increasing to a pronounced degree—probably exceeding the lapse rate prevalent at time of precipitation—the weather nevertheless was clearing while the observation was in progress. The record of uniform wind direction with altitude and the fact of rapidly rising pressure indicated that the "cold front" condition of precipitation had passed and high pressure supervened.

Pilot-balloon observations showed but few exceptions in the high altitudes to the normal wind movement from a general westerly direction. The only instance over an extended area of winds aloft having a decided easterly component occurred on the 26th and 27th, the reporting stations having been Ithaca, Lansing, and Washington. On these dates the HIGH approaching from Ontario had attained its maximum depth over the northeastern portion of the country, and the stations mentioned were in its influence. The directions reported were approximately those indicated by the surface isobars, it being characteristic of Hudson Bay HIGHS to show east component winds on their southern side.

A northeast wind in the upper levels extending to 6,000 meters was reported from San Francisco on the 7th, which was then included in a weak LOW, with a pronounced HIGH to the north. The wind ranged from southwest near the ground to southeast at 1,000 meters, above which it backed abruptly to northeast. The influence of the LOW, which caused no appreciable precipitation, apparently extended to only about 1,000 meters, above which the HIGH dominated. In connection with the fact that northern California was under the influence of persistent Pacific HIGHS during the month, to which condition has been ascribed the dryness of the month over that section (see San Francisco forecast district, this REVIEW), it is worthy of note that the resultant winds over San Francisco were northerly to northwesterly at all altitudes.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during April, 1924*

TEMPERATURE (° C.)

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters)		Drexel, Nebr. (396 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 4-year mean	Mean	Departure from 7-year mean	Mean	Departure from 6-year mean	Mean	Departure from 6-year mean
Surface	16.0	+0.7	11.4	+2.7	15.8	−1.3	5.4	+0.2	17.3	−0.9	11.2	+0.3
250	15.9	+0.7			15.5	−1.2			16.5	−1.0	10.9	+0.2
500	14.2	+0.8	10.6	+2.6	13.6	−0.8	5.1	+0.2	15.1	−0.8	8.5	+0.2
750	12.6	+0.7	8.8	+2.5	12.2	−0.5	4.1	+0.6	14.5	−0.3	7.3	+0.4
1,000	11.2	+0.3	7.1	+1.9	10.9	−0.4	3.1	+0.7	14.2	+0.2	6.0	+0.4
1,250	10.0	+0.2	5.9	+1.7	9.7	−0.3	1.9	+0.6	13.6	+0.4	4.9	+0.6
1,500	8.9	+0.2	4.3	+1.1	8.5	−0.2	0.7	+0.5	13.0	+0.5	3.7	+0.5
2,000	6.4	+0.2	2.3	+1.3	5.7	−0.2	−2.0	+0.2	10.9	+0.5	0.7	−0.1
2,500	3.4	+0.1	−0.6	+1.0	3.0	−0.5	−5.1	−0.2	7.9	+0.2	−2.1	−0.3
3,000	0.5	+0.3	−3.5	+0.9	0.1	−1.0	−8.4	−0.7	4.5	−0.4	−4.6	−0.1
3,500	−2.6	+0.3	−6.4	+1.0	−2.7	−1.3	−11.5	−0.9	1.8	−0.3	−7.0	+0.1
4,000	−5.9	0.0	−9.2	+1.3	−3.9	−0.4	−14.8	−1.1	−1.0	0.0	−8.9	+0.3
4,500	−8.7	0.0	−11.9	+1.6	−7.1	−1.4	−17.8	−1.2	−3.3	−0.3		
5,000	−11.9	0.0	−14.6	+1.9			−20.8	−1.2	−6.0	−0.4		

RELATIVE HUMIDITY (%)

Surface	59	−5	58	−7	65	+4	70	+2	77	+6	64	0
250	59	−5			65	+4			77	+7	64	0
500	56	−7	58	−7	66	+4	69	+2	75	+7	65	+1
750	55	−7	58	−7	66	+3	66	+1	70	+5	65	+2
1,000	53	−7	58	−6	66	+3	65	+2	64	+4	64	+2
1,250	51	−7	57	−6	64	+2	65	+3	58	+3	62	+1
1,500	49	−7	56	−5	62	+2	65	+4	52	+2	63	+3
2,000	49	−3	52	−6	61	+4	64	+5	45	0	71	+13
2,500	52	+1	52	−6	57	+6	66	+8	43	−1	70	+14
3,000	49	−2	54	−3	52	+7	66	+8	45	+3	66	+12
3,500	48	−6	52	−5	49	+9	66	+8	47	+3	63	+9
4,000	46	−5	50	−7	50	+10	64	+6	48	+1	54	+3
4,500	43	−5	48	−9	67	+19	60	+3	42	−1		
5,000	41	−5	46	−9			57	+3	40	−12		

VAPOR PRESSURE (*mb.*)

Surface	10.79	−0.74	7.85	+0.43	11.60	−0.79	6.01	+0.09	15.55	+0.24	8.73	0.01
250	10.66	−0.76			11.42	−0.74			14.86	+0.30	8.57	0.02
500	9.30	−0.81	7.56	+0.49	10.40	−0.38	5.87	+0.12	13.21	+0.41	7.43	+0.08
750	8.18	−0.84	6.78	+0.45	9.49	−0.31	5.30	+0.25	11.84	+0.39	6.91	+0.31
1,000	7.15	−0.92	6.00	+0.22	8.70	−0.31	4.95	+0.42	10.62	+0.61	6.29	+0.33
1,250	6.37	−0.86	5.36	+0.11	7.68	−0.42	4.54	+0.46	9.27	+0.59	5.75	+0.36
1,500	5.72	−0.73	4.78	+0.02	6.72	−0.38	4.14	+0.47	7.97	+0.65	5.46	+0.54
2,000	4.81	−0.26	3.79	−0.09	5.38	0.00	3.27	+0.33	5.99	+0.35	5.07	+.99
2,500	4.04	−0.07	3.09	−0.08	4.01	+0.16	2.75	+0.38	4.81	+0.24	4.23	+0.96
3,000	3.20	−0.21	2.56	−0.10	2.83	+0.06	2.23	+0.28	4.16	+0.51	3.40	0.81
3,500	2.55	−0.41	1.93	−0.25	1.80	−0.27	1.77	+0.17	3.74	+0.67	2.99	+0.76
4,000	1.76	−0.42	1.53	−0.21	0.76	−0.83	1.34	+0.07	3.21	+0.65	2.67	+0.74
4,500	1.37	−0.42	1.23	−0.14	0.66	−0.77	0.97	+0.02	2.58	+0.63		
5,000	1.13	−0.42	1.01	−0.09			0.71	+0.02	2.42	+0.52		

TABLE 2.—*Free-air resultant winds (m. p. s.) during April, 1924*

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		Normal		Mean		Normal		Mean		Normal		Mean		Normal		Mean		Normal		Mean		Normal	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 6° W.	1.6	S. 5° W.	2.7	S. 64° W.	2.8	S. 26° E.	0.3	N. 65° W.	1.1	S. 85° W.	1.5	N. 19° W.	1.9	N. 11° W.	1.6	S. 4° E.	1.9	S. 4° E.	2.4	S. 64° W.	1.7	S. 46° W.	2.4
250	S. 5° W.	1.6	S. 6° W.	2.8					N. 64° W.	1.1	S. 84° W.	1.6					S. 7° E.	2.5	S. 4° E.	3.1	S. 66° W.	1.8	S. 46° W.	2.5
500	S. 1° W.	2.8	S. 11° W.	4.2	S. 68° W.	3.2	S. 10° E.	0.4	N. 51° W.	2.1	S. 76° W.	2.6	N. 17° W.	1.9	N. 11° W.	1.5	S.	3.9	S. 4° W.	4.7	S. 58° W.	4.2	S. 44° W.	4.4
750	S. 9° W.	3.5	S. 16° W.	5.2	S. 72° W.	4.7	S. 64° W.	0.6	N. 67° W.	1.6	S. 69° W.	3.3	N. 29° W.	1.3	N. 20° W.	0.9	S. 6° W.	4.2	S. 12° W.	5.3	S. 68° W.	5.5	S. 48° W.	5.8
1,000	S. 21° W.	3.9	S. 27° W.	5.8	S. 74° W.	5.8	S. 68° W.	1.2	N. 87° W.	1.8	S. 63° W.	4.3	N. 64° W.	1.9	N. 50° W.	1.2	S. 31° W.	4.4	S. 24° W.	5.9	S. 68° W.	6.8	S. 54° W.	6.4
1,250	S. 35° W.	4.6	S. 37° W.	6.0	S. 78° W.	7.2	S. 77° W.	2.2	S. 81° W.	2.6	S. 69° W.	6.0	N. 76° W.	3.0	N. 56° W.	1.9	S. 40° W.	4.7	S. 34° W.	6.5	S. 76° W.	8.0	S. 65° W.	7.1
1,500	S. 43° W.	4.9	S. 51° W.	6.7	S. 80° W.	8.4	S. 82° W.	3.2	S. 83° W.	4.8	S. 70° W.	7.3	N. 75° W.	3.7	N. 58° W.	2.5	S. 48° W.	5.8	S. 39° W.	7.2	S. 83° W.	9.6	S. 73° W.	7.8
2,000	S. 61° W.	6.8	S. 61° W.	7.8	S. 89° W.	10.1	S. 89° W.	4.7	S. 86° W.	7.6	S. 80° W.	9.0	N. 81° W.	5.1	N. 72° W.	2.9	S. 69° W.	6.6	S. 50° W.	8.2	S. 87° W.	11.2	S. 82° W.	8.7
2,500	S. 78° W.	8.1	S. 71° W.	8.6	N. 89° W.	12.1	W.	6.6	S. 81° W.	11.4	S. 82° W.	10.7	S. 83° W.	8.5	N. 82° W.	4.6	S. 69° W.	7.3	S. 58° W.	9.1	N. 85° W.	13.0	S. 86° W.	9.1
3,000	S. 85° W.	10.1	S. 81° W.	8.8	N. 77° W.	12.6	N. 87° W.	9.1	S. 79° W.	7.8	S. 85° W.	10.8	N. 86° W.	10.4	N. 80° W.	6.2	S. 71° W.	9.0	S. 63° W.	11.2	N. 80° W.	12.3	S. 87° W.	10.9
3,500	S. 82° W.	11.8	S. 85° W.	11.8	N. 79° W.	12.5	S. 89° W.	10.7	W.	16.4	N. 85° W.	12.2	S. 87° W.	11.2	N. 84° W.	7.8	S. 71° W.	10.3	S. 70° W.	10.6	N. 86° W.	13.2	S. 80° W.	12.0
4,000	S. 85° W.	11.2	S. 82° W.	12.8	W.	11.8	N. 87° W.	12.6	S. 89° W.	20.8	N. 75° W.	14.7	S. 77° W.	11.7	N. 82° W.	8.6	S. 85° W.	11.8	S. 83° W.	12.8	N. 86° W.	17.4	S. 85° W.	13.5
4,500	S. 76° W.	13.3	S. 76° W.	15.6	N. 85° W.	15.5	N. 78° W.	13.8	N. 68° W.	22.8	N. 50° W.	15.2	S. 88° W.	8.6	N. 69° W.	8.1	S. 85° W.	13.4	S. 79° W.	14.0	N. 45° W.	15.1	S. 87° W.	11.2
5,000	S. 77° W.	15.2	S. 77° W.	15.2	N. 86° W.	18.8	N. 84° W.	17.5					W.	18.2	N. 74° W.	16.3	S. 79° W.	15.5	S. 85° W.	14.6				

THE WEATHER ELEMENTS

By P. C. DAY, Meteorologist, in Charge of Division

PRESSURE AND WINDS

Changes in barometric pressure were frequent, but the cyclones and anticyclones usually lacked important proportions, the cyclones in particular often appearing quickly, moving over short and occasionally erratic paths, developing unforeseen energy for brief periods, and dissipating unexpectedly. Good illustrations of these tendencies appear on the daily weather maps for the first few days of the month.

On the morning of the 1st a slight cyclonic formation appeared over North Carolina. As this depression moved northward along the coast it developed marked intensity, reaching eastern New England on the morning of the 2d as a storm of great severity, though of rather small extent, and bringing high winds and thunderstorms along the coast and unusually heavy snowfall from Maryland and Delaware northeastward, the depth of fall ranging up to 15 inches or more.

Again on the night of the 6th–7th a storm developed over the Middle Atlantic States and by 8 a. m. of the 7th was central over southern New England as a cyclone of marked intensity, attended by high winds, heavy rains, and material snowfall, particularly in northern new England. This storm maintained its severe character for a somewhat longer period than did the one just preceding, but it also quickly dissipated after the 8th.

Another storm of somewhat erratic character, particularly as to its unusual northward movement, first appeared on the morning of the 14th over Wyoming and 24 hours later had advanced to northern Colorado, with a sharp fall in pressure over the middle Plains region. By the morning of the 16th the center had advanced to the Dakotas and Minnesota, and general rains or snows had occurred over wide areas between the Great Lakes and Rocky Mountains. Within the following 48 hours it moved to the northward of Lake Superior.

On the morning of the 18th a trough of low pressure extended from the lower Lakes to the Gulf coast, attended by general and frequently heavy rains. This depression developed into a cyclone of considerable proportions and had moved to eastern Massachusetts by the following morning, the heavy rains extending into the Northeastern States. Generally speaking, this storm gave the heaviest precipitation of the month over a large area from the Middle Gulf States northeastward to New England.

On the morning of the 24th a rather extensive cyclonic storm had advanced into the middle Plains, but with little precipitation up to that time, save for light rains and thunderstorms to the northeastward and local light snows to the westward of the principal center. During the following 24 hours high pressure, advancing from the far Northwest, appeared to have partially broken up the cyclonic formation and crowded it to the southward, while increasing pressure over the Mississippi Valley and Great Lakes prevented the usual eastward progress. As a result of this delayed movement precipitation was rather general between the Mississippi River and the Rocky Mountains, snow falling over many of the elevated districts to the westward and some heavy rains occurring over the Southern Plains. By the morning of the 26th, however, the storm had again assumed a definite formation with its center over western Iowa, but high pressure advancing southward from the vicinity of Hudson Bay still effectually hindered any eastward movement and it was finally forced to the northwestward and dissipated.

The most important cyclone of the month, from the viewpoint of damage wrought by the attending series of tornadoes, developed rather suddenly in Kansas on the morning of the 29th and is described in some detail elsewhere in this REVIEW; see page —.

Anticyclonic conditions persisted during much of the month over the north Pacific coast districts, although but few important high areas moved inland from this region sufficiently to affect the weather to eastward of the Rocky Mountains.

The most important anticyclones of the month from the Rocky Mountains eastward had their origin in the Hudson Bay region, their influence on the weather being mainly felt from the Great Lakes eastward.

The average pressure for the month was less than normal over practically all portions of the country from the Great Plains eastward, and above normal to the westward, save for a small area embracing most of California, where the average was slightly less than normal. Over the far Northwest the average pressure was distinctly high, while in the upper Mississippi Valley region it was correspondingly low.

In the absence of important pressure gradients the winds were not prominently from any particular direction, although they were mainly from the south in the middle and southern portions of the Mississippi Valley and Great Plains, and from westerly points over the Atlantic and Pacific coast States.

The principal high winds were associated with storms of the 1st and 2d and 7th and 8th, along the North Atlantic coast, and on the 29th–30th in connection with the numerous tornadoes that occurred over the Southern States on those dates. Over the Pacific coast districts no important high winds were observed.

TEMPERATURE

The first few days of the month were abnormally cold over the greater part of the country from the Rocky Mountains eastward, the morning of the 1st being particularly cold over the north-central districts where at a few points it was the coldest ever observed so late in the season, while farther south there were a number of instances where the temperatures were equal to, or nearly as low as previously observed in April.

The week ending April 8 was generally mild over all western and northwestern districts, and decidedly cool over the Southeast, the line of freezing temperature extending well into the Middle Gulf States. The week following was without important temperature changes, and was on the whole moderately warm over all interior portions. The week ending April 22, had mainly moderate temperatures, save that some unusual cold occurred during the early part in the Plateau region and about the same time it was distinctly warm in the central valleys. For the week as a whole it was generally cold over all northern and most western districts and moderately warm in the Ohio and middle Mississippi Valleys. The last week of the month had mostly moderate temperatures, although about the 24th to 26th it was cold over the northern Plateau, points in Washington having temperatures on the 24th as low as, or lower than previously reported so late in the month.

As a whole the month was warmer than normal in the central valleys and over the far Western States. It was unusually warm in northern California and the adjacent portions of Oregon, Red Bluff, Calif., reporting the

month as the warmest April of record. In the Rocky Mountain and southern Plateau districts the month was moderately cold, but elsewhere the departures above or below normal were mainly small.

The warmest periods of the month were about the middle over much of the Great Plains and thence eastward to the Ohio Valley and into portions of the Gulf States; in the early part of the last decade over many northern sections from the Great Lakes to the Dakotas and over the Rocky Mountains; and near the end of the decade over the Northeastern States and generally over the Plateau and Pacific Coast States. The highest observed temperature, 107°, was reported from Texas, and temperatures of 90° or higher were reported from most Central and Southern States.

The most important cold period of the month east of the Rocky Mountains was near the beginning; the 1st being particularly cold over the central valleys and upper Lake region, where temperatures were far below freezing, and in some instances, notably in the northern portions of Wisconsin and Michigan, were from 15° to 25° or more below zero. West of the Rocky Mountains the dates of lowest temperatures varied greatly, but were mainly after the middle of the month.

PRECIPITATION

The country as a whole had deficient precipitation, although there were important areas in the east Gulf States, and from the upper Ohio Valley and Middle Atlantic States northeastward, with monthly amounts materially above normal; in fact, over the eastern portions of Maryland, Pennsylvania, and New York, in New Jersey, and western New England the month was unusually wet, and similar conditions existed in portions of Georgia and nearby States where locally the precipitation exceeded 10 inches, and was, in some instances, among the greatest of record for April. Precipitation was above normal also in portions of Arkansas, Kansas, and Oklahoma, locally in the far Southwest, and over a considerable area from central Michigan northwestward to eastern Montana.

In portions of the middle Mississippi and lower Missouri Valleys the month's rainfall was much less than normal, and locally in Iowa it was as dry as ever known in April. Likewise in the far West there was everywhere far less than the normal precipitation, save in portions of Arizona and southern California. Over most of the States last named and thence northward there was a marked deficiency in precipitation. In California April was the seventh month with precipitation for the State as a whole below normal, and in the northern portions it was locally the driest April of record, and the drought at the end of the month had become the worst ever experienced in the history of the State.

SNOWFALL

The storm over the North Atlantic coast on the 1st and 2d brought unusually heavy snows for April from northern Virginia to New England. Indeed over much of this territory the total fall was the greatest ever known so late in spring, and locally in southern New England it was heavier than recorded at any time during the preceding winter. Again on the 7th and 8th snow fell over considerable areas in the Northeastern States, reaching depths of nearly 10 inches in northern New England; this again broke the record for heavy snow so late in the season. On the 11th some heavy snows were reported from north-central Iowa; and on the 16th and 17th considerable snow accompanied the general unsettled conditions that prevailed over the Great Plains and Rocky Mountains on these dates.

In Minnesota heavy, wet snow fell on the 21st, the depths ranging up to 10 inches or more.

In the mountains of California and adjacent States there was little new snow during the month and that on the ground melted rapidly, so that the main highways through the mountains were passable at the earliest date of record. Despite the rapid melting of the remaining snow in the mountains, streams in California were reported at summer stages. In Arizona there was a good run-off, and prospects for water were mainly good in New Mexico, Wyoming, and other portions of the Rocky Mountain system. East of the Rocky Mountains some snow still remained on the ground at the month's end in northern New England.

RELATIVE HUMIDITY

The relative amount of moisture in the atmosphere was largely deficient as compared with the normal over most far western districts, and there were important deficiencies in the interior portions of the country. Elsewhere the percentages of humidity were mainly close to normal.

Much cloudy weather prevailed over the Ohio Valley and Great Lakes region and to the eastward, while over the Plateau and adjacent areas there was much sunshine.

SEVERE LOCAL HAIL AND WIND STORMS, APRIL, 1924

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the annual report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Justin, Tex. (near) to Edgewood, Tex. (near)	3	3 p. m.	20–100	1	$41,000	Tornado accompanied by hail.	Serious damage confined to Denton and Dallas Counties over a path 30 miles long; entire length of path 80 miles; 14 injured; loss by hail $1,500.	Official, U. S. Weather Bureau.
Fort Wayne, Ind.	8					Electrical and hail.	Telephone and light and power lines damaged.	Do
Parsons and Columbus, Kans.	8-9				$3,000–5,000	Wind and hail.	Electric-light globes, greenhouses, automobile tops, and garden truck damaged.	Do.
Lavaca County, Tex.	9		4 miles			Hail.	Storm extended from Breslau to Shiloh. Spring crops and fruit destroyed, chickens killed, and windows broken.	Do.
Uvalde, Tex. (near)	10		5 miles			do.	Crops and buildings considerably damaged.	Do.
Comilla, Ga.	14	9 p. m.			3,000	Tornado.	Some property damage.	Do.
New Orleans, La.	17	8 to 8:30 p. m.	6 miles		107,000	Wind and hail.	A number of small houses damaged or displaced; greenhouses and gardens injured by hail; 50 persons injured; length of path 25 miles.	Do.
Granbury, Tex.	22	6:30 p. m.				High wind.	Church completely demolished, other damage to roofs and poles. Storm was preceded by violent hail which did considerable damage to windows.	Dallas Morning News (Texas).

Severe local hail and wind storms, April, 1924—Continued.

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Mills County, Tex. (eastern part of).	22		4 miles			Heavy hail	Crops destroyed; roof of building damaged; poultry killed.	Official, U. S. Weather Bureau.
Berne, Ind. (near)	22					Tornado	No damage reported	Do.
St. Francisville, La. (near)	23	4:30 p. m.				Heavy hail	Orchards and gardens injured	Do.
Jacksonville, Tex. (tomato belt around).	23		3 miles		50,000–100,000	Hail	Crops destroyed and considerable damage to roofs and window glass.	Do.
Munday, Tex. (near)	24				10,000	Heavy hail	Extensive crop damage	Do.
Pearl, N. Mex	24	4:30 p. m.	¼ mile			do	Some fruit beaten off and minor injury to gardens.	Do.
San Marcial, N. Mex	24	2:45 p. m.				do	Fruit severely damaged	Do.
Stith, Tex. (near)	24–25		5 miles			do	Crops damaged or destroyed over wide area; path 10 miles long.	Do.
Slick, Okla. (5 miles SE. of)	25	A. m.		3		Tornado	1 home demolished and several persons injured; strip several feet wide and mile long devastated.	Dallas Morning News (Texas).
Benson, Ariz. (7 miles W. of)	25	10:45 a. m.				Heavy hail	Considerable damage	Official, U. S. Weather Bureau.
Rockville, Ind	25					Electrical and wind.	Several trees struck and barn burned	Do.
Buckner, Ky	25	7–8 p. m.	2 to 3 miles.			Moderately heavy hail.	Crops and buds of fruit trees considerably injured.	Do.
Travis County, Tex. (between Carl and Colton).	26	5 a. m.	50	5	25,000	Tornado	Some property damage; 15 persons injured; path 4 miles long.	Do.
Hondo, Tex. (near)	26					Hail	Fruit knocked off and considerable damage to window glass and roofs.	Do.
Grand Coteau, La. (4 miles NW. of).	28	3 p. m.				Light to heavy hail.	A few cotton fields damaged; minor damage by wind to buildings.	Do.
Ford County and northern parts of Clark, Kiowa, and Meade Counties, Kans.	28		10 miles		1,050	do	Growing crops injured; some damage to windows.	Do.
Many, La	29	6:30 p. m.	450–900	1	100,000	Tornado	Many buildings destroyed or damaged; several persons injured.	Do.
Crichton, La	29	P. m.	60 yards.			do	Several persons injured; 4 houses destroyed	Do.
Texarkana, Ark. (N. of)	29	2:30 p. m.	100	1	25,000	do	Everything in path destroyed; 17 persons injured; path ¼ mile long.	Do.
Covington to Ingalls (near Stillwater), Okla.	29	A. m.		1		do	A number of buildings and 15 oil derricks destroyed; 2 injured.	Tulsa Tribune (Oklahoma).
Columbia, S. C	30	11:05–11:55 a. m.	3 to 6 miles.	1	60,000	Hail and rain	Damage principally to window panes, skylights, greenhouses, and roofs.	Official, U. S. Weather Bureau.
Autauga County, Ala.	30	2:45 a. m.			30,000	Tornado	2 persons slightly injured	Do.
Chambers County, Ala. (between Welsh and Roanoke).	30	4:30 a. m.		1	25,000	do	6 persons injured	Do.
Butler to Macon Counties, Ala.	30	4:50–6:30 a. m.		8	80,000	do	30 persons injured; 15 or 20 buildings near Thompson destroyed.	Do.
Lee County, Ala., to Meriwether County, Ga.	30	5–6:15 a. m.		15	60,000	do	4 deaths in Alabama; 11 in Georgia; greatest loss of life and property in Chipley, Ga.	Do
Pike and Barbour Counties, Ala.	30	6–7:15 a. m.		1	70,000	do	Heavy property damage; greatest near Louisville; 37 persons injured in Barbour County alone.	Do.
Lawrenceville, Ga., to Hickory Grove, S. C.	30	6–11 a. m.	100–1,300	10	2,200,000	do	Heavy property damage; path 185 miles long, 110 of which are in South Carolina; numerous injuries.	Official U. S. Weather Bureau; Piedmont (Greenville, S. C.).
Albany, Ga	30	7 a. m.			1,000	do	Damage chiefly to shade trees	Official, U. S. Weather Bureau.
Brookton to Cornelia, Ga	30	9–9.35 a. m.			51,000	do	4 injured at Brookton; damage mostly at Cornelia.	Do.
Reynolds, Ga	30	8:30 a. m.			30,000	do	30 people injured	Do.
Ficklin, Ga	30	9:30 a. m.		1	25,000	do	10 injured; village practically destroyed	Do.
Macon, Ga. (3 miles SW. of)	30	do	15–300	3	200,000	do	40 injured; many buildings wrecked or moved off foundations; fruit and forest trees ruined	Do.
Fitzgerald, Ga	30	10 a. m.			50,000	do	3 persons injured	Do.
Sylvania, Ga	30	12:45 p. m.			1,000	do	Minor property damage	Do.
Butler, Ga	30				10,000	Light hail and wind.	Damage by wind	Do.
McRae, Ga	30				5,000	Heavy hail	Orchards injured	Do.
Millen, Ga	30				10,000	do	Damage principally to crops; some stones 2 inches in diameter.	Do.
Aiken (near) to Pamplico, S. C.	30	11 a. m.–2:45 p. m.	300–1,400	67	1,000,000	Tornado	Heavy property damage; path 130 miles long	Do.
Pittsboro, N. C. (near)	30	12:30 p. m.	100–300	4	20,000	do	Path 2 miles long; 5 persons hurt	Do.
Martin County, N. C.	30	2:30 p. m.	100–300	1	200,000	do	40 persons injured; 80 buildings damaged or destroyed; 15-mile path.	Do.
Amelia Co., Va	30	5:30 p. m.	100–300	1	30,000	do	Path 10 miles long; several persons injured	Do.
Greensville Co., Va	30	do	40		1,000	do	1 building destroyed; very short path	

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

A disturbance of slight intensity that was over the Carolinas on the morning of the 1st moved northeastward with rapidly increasing intensity and was centered over Maine as a storm of marked energy 24 hours later. Shifting gales occurred generally from Cape Hatteras northward, several stations reporting maximum wind velocities exceeding 50 miles an hour, the highest being 68 miles an hour from the northeast at Atlantic City, N. J. Storm warnings were issued for the area affected well in advance of the occurrence of high winds.

During the night of the 3d–4th a disturbance developed over the northeastern Gulf of Mexico and was centered near Pensacola, Fla., at 8 a. m. of the 4th. At the same time pressure was abnormally high over the Carolinas and the Middle Atlantic States, so that strong northeast and east winds seemed probable along the Atlantic coast from Savannah northward to Cape Hatteras. Storm warnings were ordered displayed at 10 a. m., but the disturbance gradually dissipated and no winds of gale force occurred.

On the morning of the 6th pressure was abnormally high over the Canadian Maritime Provinces, and a disturbance was moving eastward over the Lake region, with strong evidences of the development of a secondary over the Middle Atlantic States. Accordingly southeast storm warnings were displayed from Delaware Breakwater to Eastport, Me. The secondary disturbance developed during the 6th and moved rapidly northeastward, with a marked increase in intensity, so that strong

east and southeast gales occurred at all stations along the coast from Delaware Breakwater northward. While both Atlantic City and New York City reported a maximum velocity of 64 miles an hour, the velocity of 52 miles an hour from the east at Portland, Me., indicated that the storm was most severe in that locality. Due to the exposure of the anemometer at Portland the maximum wind velocity there seldom reaches 50 miles an hour.

The next disturbance to cause strong winds along the Atlantic coast was that of the 18th–19th, for which storm warnings were displayed along the New England coast the evening of the 18th. Again on the 20th warnings were displayed from Delaware Breakwater to Nantucket, Mass., in connection with a disturbance that moved rapidly eastward from Lake Erie to the southern New England coast.

At 8 p. m. of the 21st a disturbance of considerable energy was over the upper Ohio Valley and the southern Lake region and moving eastward, and southeast storm warnings were issued at 9:30 p. m. for the Atlantic coast from Cape Hatteras northward. These warnings were fully verified, the highest velocity reported being 56 miles an hour from the northwest at New York City.

The last storm warnings of the month were ordered during the afternoon and evening of the 30th from the Virginia Capes to Eastport, Me., in connection with a disturbance of marked intensity that moved rapidly from the lower Ohio Valley to New England. Several stations reported maximum velocities of between 45 and 50 miles an hour from the southeast.

Frost warnings were issued for portions of the South Atlantic and East Gulf States on the 1st and 2d, but no further warnings for the Southeastern States were required during the month, and none for any section until the 17th. During the week beginning on that date warnings were issued for limited areas in the Ohio Valley and the Middle Atlantic States.—*Charles L. Mitchell.*

CHICAGO FORECAST DISTRICT

The month, as a whole, was moderately warm and dry in the central and southern portions of the district, and wet and cold from northern Lake Michigan westward and northwestward across the Red River of the North Valley.

Special warnings issued during April were chiefly confined to those in anticipation of frost, but the season was somewhat later than the average, and, in consequence, warnings were not of much importance.

The principal storm of the month appeared beyond the Rockies on the 13th, and gradually developed and moved eastward, the center reaching the Middle Missouri Valley on the 15th, the Middle Mississippi Valley on the 16th, and the northern Lake region on the 17th. Heavy snow accompanied the storm in the Rocky Mountain region and northern Plains, and cold weather followed in its rear, frost being reported on the 18th to the southern limits of the region.

Livestock warnings were sent on the 15th to Nebraska and Wyoming; advices of frost to various points as occasion demanded; also advisory messages to open ports on Lake Michigan for strong shifting winds. The regular season for navigation did not commence until April 20.—*H. J. Cox.*

NEW ORLEANS FORECAST DISTRICT

The weather during April, 1924, was marked by several well-defined troughs of low pressure, which generally weakened in passing eastward over this district; but the last trough of the month, passing eastward on the 28th–30th, increased in intensity.

The month opened with cool weather and extensive frosts in the interior sections, but thereafter the areas of high pressure following the troughs did not carry cold weather far southward, frosts being generally limited to the northwestern portion and freezing temperature to the extreme northwestern portion of the district. Ample notice was given for all frosts and freezes and warnings were sent also to stockmen for the freezes that occurred in the Texas Panhandle and northwestern Oklahoma on the 17th and 26th. The dates of frost warnings, which were issued mostly for the northwestern portion of the district and occasionally for northern Arkansas, were the 1st, 9th, 17th, 18th, 26th, 29th, and 30th.

On the morning of the 25th, in the southern end of a long trough of low pressure, a disturbance appeared over the Rio Grande Valley. Southeast storm warnings were issued at 8:30 a. m. for strong southerly winds and squalls on the Texas coast. The wind increased considerably and moderate to fresh gales occurred during the afternoon, though the morning and night weather maps showed only moderate pressure gradient, and the storm diminished in intensity thereafter. There were no storms without warnings. Small craft warnings were advised for the Texas coast on the 15th, 16th, 25th, and 26th.

Fire-weather warnings were sent to addresses in Oklahoma and Arkansas on the 15th and 24th and conditions occurred as forecast.—*R. A. Dyke.*

DENVER FORECAST DISTRICT

On the morning of the 15th a pronounced area of low pressure was central over southeastern Wyoming, while the barometer was moderately high and rising over the North Pacific States. Cold wave and livestock warnings were issued for northern and eastern Colorado and northeastern Arizona, and livestock warnings alone for northern New Mexico. The ensuing weather was in full agreement with the warnings.

Another pronounced low-pressure area began crossing the district from the west on the 23d, being followed by high pressure from the northwest, consequently forecasts of rain turning to snow and colder weather were issued for the sections within its influence, timed to accord approximately with the pressure movem nts. Pressure gradients intensified during the day and night sufficient to produce a cold wave in northeastern Colorado.

Another disturbance, which manifested but little energy in crossing the district, developed marked energy by the morning of the 29th over southern Kansas and Oklahoma, while a HIGH was building up to the northwest, consequently livestock warnings were issued for eastern Colorado for colder weather, with snow. The ensuing fall in temperature was comparatively small and precipitation was mostly rain on the lower ranges, but snow on the more elevated ones.

Frosts and temperatures near or below freezing were of very frequent occurrence during the month, and the number of warnings to interested districts was correspondingly great.

Warnings were already being issued at the beginning of the month for the fruit districts in which protective measures are taken in southern New Mexico, and fruit advanced so as to become susceptible to injury by April 9th in southeastern Colorado, by the 12th in the Colorado Valley in Colorado, and about the 29th in the Gunnison Valley in Colorado.

Warnings of expected frosts of a less serious character were issued as follows:

For all of southern New Mexico on the 16th, 17th, 25th, and 26th; for extreme southeastern New Mexico on the

5th, 12th, 19th, 20th, 24th, and 27th; for northern New Mexico on the 27th, 29th, and 30th; for southeastern Colorado on the 12th, 18th, 19th, 20th, and 21st; for the Colorado Valley in Colorado on the 14th, 18th, 19th, and 21st; for all of Colorado on the 27th and 30th; for southeastern Arizona on the 15th, 17th, 25th, and 26th; for south central Arizona on the 25th; and for northwestern Utah on the 17th, 18th, 19th, 21st, 24th, 25th, 26th and 27th. These warnings were generally justified by the actual occurrence of frost or by the critical temperatures for frost.

Warnings of more severe temperatures embracing those close to or below freezing were issued as follows: 1st and 3d, extreme southeastern New Mexico; 9th, southeastern Colorado, 15th, Colorado and Utah; 16th Colorado, Utah, and extreme southeastern New Mexico; 17th, Colorado and extreme southeastern New Mexico; 24th, Colorado; 25th and 26th, Colorado and northern and extreme eastern New Mexico; and the 29th for Colorado. In nearly every case these warnings were fully verified.—*Lawrence C. Fisher.*

SAN FRANCISCO FORECAST DISTRICT

April in the San Francisco Forecast District was usually dry, due to the persistence of ocean high-pressure areas impinging upon the California and Oregon coasts. They prevailed, with slight variations, practically during the entire month. There were about as many Bering Sea and Gulf of Alaska storms as usual, but they moved inland too far north to cause any great amount of rain in the Pacific States. On the 20th a small disturbance was located off the California coast, which moved inland on the 23d, and in doing so caused a small amount of rain in the southern half of California. Rain also fell during the first few days of April quite generally throughout the district. Nearly all the storms that occurred passed from the ocean inland over northern British Columbia to Alberta and thence formed a trough of low pressure that extended south through Idaho and Nevada. The lower end of the trough when over southern Nevada received sufficient moisture from the ocean to cause some few showers in California and Nevada. The drought, however, in the former State is the worst that has been experienced since the establishment of the Weather Bureau, as up to the end of April only about 50 per cent of the normal rainfall has occurred in California. The droughty situation is worse in the northern portion of the State than in the southern, which is very unusual. The nearest approach to the present dry spell occurred during the season of 1897–98, when only 54 per cent of the normal amount of precipitation was received during that season and the southern part of the State suffered most, which is just the opposite to the present conditions.

Frost warnings were issued in the north Pacific States on 15 days and in northern California on two days. No damage was done by frosts in California; but they were unusually severe in portions of the north Pacific States, where crops were badly injured.

Storm warnings were displayed at the entrances to the Gulf of Georgia and the Strait of Fuca and at the mouth of the Columbia River on the 17th. Small-craft warnings were ordered at a few places on the 15th, 18th, and 23d.

Livestock warnings were issued on April 3 for eastern Oregon, Nevada, and southern Idaho; and fire-weather warnings were issued on the evening of the 24th for northern California. All of these warnings were justified except the fire-weather warning was not followed by as high temperature as expected.—*E. A. Beals.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD, Meteorologist

At the close of March, 1924, the Ohio River was in flood as far down as the mouth of the Great Kanawha River. The crest stage at Point Pleasant, W. Va., on the Ohio River was 44.5 feet on April 2. Below Point Pleasant, flood stages were not recorded until Cloverport, Ky., was reached. From this place to Shawneetown, Ill., just below the mouth of the Wabash River, the crest stages varied from 0.7 foot to 4.1 feet above the flood stages, the greatest excess at Shawneetown. Below Shawneetown the river was 5 or more feet below the flood stage, and the crest passed into the Mississippi River on April 11, with a stage of 40.7 feet at Cairo, Ill., reaching the Gulf of Mexico about April 25.

The flood was very accurately forecast and there was no damage of consequence, although some inconvenience and delay in farm work resulted. In the vicinity of Shawneetown, Ill., property to the amount of $10,000 was saved through the warnings.

There were no floods of moment in the tributary streams in the State of Ohio. Such as occurred were properly forecast and the damage was very small. The flood in the White River of Indiana and its forks was also moderate, the crest stages ranging from about 2 to 5 feet above the flood stage. Owing to the backwardness of the growing season the damage was small, probably not over $10,000. However, the warnings allowed the removal of considerable property from bottom lands.

The flood in the Wabash River of Indiana and Illinois attained fair proportions on account of the rapid melting of the heavy snows that fell over northern Indiana on March 20–21. The flood was most marked at La Fayette, Ind., where the crest stage of 21.2 feet on March 31 was 10.2 feet above the flood stage. Warnings were issued as often as necessary, and there were no losses of livestock nor other portable property. Losses from other sources, flooding of basements, highways, etc., amounted to about $4,000. The value of property saved through the warnings was about $5,000.

Flood warnings for the lower Connecticut Valley were issued on April 7 after a 24-hour rainfall that was excessive over the lower valley, and at 9 p. m., April 8, the Connecticut River at Hartford, Conn., reached a stage of 20.7 feet, 4.7 feet above flood stage. There was no damage done along the main stream, but the smaller rivers were dangerously high, especially the Farmington and Park Rivers. It was impossible to obtain estimates as to the amount of damage done.

Warnings were again issued on April 15 for the lower valley and on April 18 and 19 for the entire valley after the heavy rains that began during the afternoon of April 18. The flood was a moderate one and the warnings were well verified. No damage was reported.

The heavy rains of April 6–7, together with some melted snow, also caused a marked flood in the Hudson River at Troy and Albany, N. Y., the river reaching 20.3 feet at Troy and 14.6 feet at Albany, 5.3 and 2.6 feet, respectively, above the flood stages. Warnings were issued promptly and the reported losses were small, only about $7,400, while the saving through the warnings was perhaps $2,500.

Flood conditions in the north branch of the Susquehanna River were very similar and were equally well forecast. The damage done, however, was somewhat greater, more than $25,000, probably because a larger area was covered.

There were some minor floods in the rivers of the south Atlantic system and in the upper Coosa River of Georgia

and Alabama. All passed off without damage of consequence. Little planting had been done, and the rivers of the Santee system had been high for so long a period that there was no livestock in the swamp regions.

The Tombigbee River at Demopolis, Ala., was in flood from April 14 to 27, inclusive, with crests on April 16 and 24 of 42.9 and 48.2 feet, respectively, flood stage being at 39 feet. The Tombigbee River was also in flood on April 18 and 19, with a crest stage of 52.7 feet at 10 a. m., April 19, or 6.7 feet above the flood stage. Damage as reported amounted to $15,500. Value of property saved through warnings, $11,900.

The heavy rains of April 10–11 over the drainage area of the Pearl River of Mississippi resulted in a somewhat prolonged period of moderately high water. Warnings were timely and no damage was reported.

The Illinois River had been high throughout March and remained generally so during April. Some additional warnings were necessary and they were well verified. No damage of consequence occurred.

The following description of a flood in the Belle Fourche River of South Dakota was prepared by Mr. Harley N. Johnson, meteorologist in charge of the Weather Bureau Office at Rapid City, S. Dak.:

FLOOD WATERS IN THE BELLE FOURCHE RIVER, WESTERN SOUTH DAKOTA

Due to moderately high temperatures and warm showers, a heavy blanket of snow approximately 5 feet deep overlying the headwaters of the Belle Fourche River near Moorcroft and Gillette, Wyo., melted rapidly and caused the highest water in the Belle Fourche River known to the oldest inhabitants. The highest stage of water was approximately 3 feet above any previous high-water mark The water, already high, began rising further on Sunday, April 6, and reached the maximum stage at Belle Fourche about noon, Wednesday, April 9. Ample warnings of the approach of the flood were given to the people living on the lowlands, which was no doubt responsible for no lives being lost. Fifty-five families were rendered homeless, a total of 168 people, and property loss or damage is estimated from $125,000 to $150,000. Practically all the furniture in the 55 homes inundated is a total loss. The water reached the main street of the city of Belle Fourche and many residences and business houses had water in the basements. The Wood Lumber Co. lost heavily by its finished product being washed away, and the burning of its mill, which was washed from its foundation and lodged against the bridge. To prevent the possible going out of the bridge by reason of the resulting jam the lumber was removed from the mill and the mill then fired.

About 50 feet of the railroad bridge north of the town was washed away and the approaches to the new steel bridge were damaged and the bridge itself was saved only after a hard struggle. The steel and wood bridge east of the Powers Garage had to be dynamited to break up a jam, and the bridge across Redwater Creek near the high school was washed away. Ranches all along the valley of the Belle Fourche were heavily damaged by the flood waters.

Relief work by the Red Cross, whose representatives arrived at Belle Fourche on Saturday, April 12, did much to alleviate the suffering of the homeless people.

Two men lost their lives near Dalzell, in Meade County, on Wednesday, April 2, while attempting to cross the Belle Fourche River in a ferryboat. The cable gave way under the strain of the high water, and the men, Peter Richards and John Newcombe, were swept down the swollen stream. Only one of the bodies has been recovered to date, and it was washed ashore 5 miles downstream from the place where the men were drowned.

Very heavy rains on April 29 over the lower Arkansas Valley caused a decided rise in the Arkansas River and its tributaries, except the Canadian, and the rise was still in progress at the close of the month. It will be described briefly in the MONTHLY WEATHER REVIEW for May, 1924.

A rise to 5.5 feet in the North Platte River at North Platte, Nebr., or 0.5 foot above the flood stage, on April 18–19 was doubtless due to heavy rains and some melting snows at headwaters in the State of Wyoming. No damage was done.

The lower Trinity River of Texas was in flood or rising rapidly at the close of the month of March, and the crest did not pass Liberty, Tex., until April 11. The flood was moderate and no material damage resulted. Another marked rise set in below Fort Worth after the heavy and general rains of April 26–27, and the high water continued at the end of the month. At Dallas, Tex., the estimated crest stage of 31 feet on April 28 was 6 feet above the flood stage. Further details will be given in the MONTHLY WEATHER REVIEW for May, 1924.

The melting of unusually heavy snowfall over the upper drainage area of the Rio Grande and the Colorado River caused exceptionally early rises in the rivers, and flood warnings for the Rio Grande in the State of New Mexico were issued beginning with April 7. The river at Albuquerque did not quite reach the flood stage of 4 feet, but below that place the river was in flood from April 7 until after the close of the month. Fortunately no damage was done, although a serious situation prevailed at San Marcial, N. Mex., where Mr. George W. King, the river observer, reported: "The water level during the last rise (April 27–29) was easily 6 feet above the level of the town and our dikes are none too strong." Warnings were also issued for the lower Colorado River and flood stages were slightly exceeded in some localities.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
Connecticut:	*Feet*			*Feet*	
White River Junction, Vt	15	20	20	15.7	20
Hartford, Conn	16	8	12	20.7	8
		16	16	16.2	16
		20	25	17.7	21
Hudson:					
Troy, N. Y	15	7	8	20.3	8
Albany, N. Y	12	7	8	14.6	8
Susquehanna:					
Binghamton, N. Y	14	7	8	15.2	7
Towanda, Pa	16	7	7	17.8	7
Wilkes-Barre, Pa	20	7	8	23.5	8
Harrisburg, Pa	17	8	8	17.0	8
Unadilla:					
New Berlin, N. Y	8	6	10	11.8	7
Chenango:					
Sherburne, N. Y	8	7	8	9.3	7
Cape Fear:					
Elizabethtown, N. C	22	14	14	22.4	14
Peedee:					
Mars Bluff, S. C	17	17	24	18.8	16
Santee:					
Rimini, S. C	12	5	28	15.3	10
Ferguson, S. C	12	(1)	2		
		5	(2)	13.8	11
Saluda:					
Pelzer, S. C	7	30	(2)		
Chappells, S. C	14	6	6	15.5	6
EAST GULF DRAINAGE					
Apalachicola:					
River Junction, Fla	15	22	22	15.1	22
Coosa:					
Gadsden, Ala	22	20	22	22.4	20
Lock No. 4, Lincoln, Ala	17	20	23	17.5	21
Tombigbee:					
Lock No. 4, Demopolis, Ala	39	14	27	48.2	24
Black Warrior:					
Lock No. 10, Tuscaloosa, Ala	46	19	21	52.7	19
Pearl:					
Jackson, Miss	20	14	(2)	25.4	22
GREAT LAKES DRAINAGE					
Maumee:					
Fort Wayne, Ind	15	(1)	3		
Napoleon, Ohio	10	(1)	1		
St. Joseph:					
Montpelier, Ohio	10	(1)	1		
Auglaize:					
Defiance, Ohio	10	(1)	1		
MISSISSIPPI DRAINAGE					
Ohio:	*Feet*			*Feet*	
Pittsburgh, Pa	22	(1)	1		
Dam No. 6, Beaver, Pa	30	(1)	(2)		
Dam No. 12, Wheeling, W. Va	36	(1)	(3)		
Marietta, Ohio	33	(1)	2	39.1	1
Parkersburg, W. Va	36	(1)	2	40.2	1
Dam No. 19, Tallman, W. Va	39	(1)	2	40.7	1
Dam No. 22, W. Va	42	(1)	2	44.0	2
Point Pleasant, W. Va	40	(1)	3	44.5	2
Dam No. 29, Normal, Ky	50	2	3	50.5	2
Portsmouth, Ohio	50	2	3	50.8	2
Cloverport, Ky	40	5	7	40.7	6
Evansville, Ind	35	3	10	38.3	7
Henderson, Ky	33	4	10	36.1	7, 8
Dam No. 48, Cypress, Ind	42	4	10	45.7	8
Mount Vernon, Ind	35	5	11	37.6	8
Shawneetown, Ill	35	5	12	39.1	9

[1] Continued from last month.
[2] Continued at end of month.
[3] Below flood stage at 8 a. m. April 1.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI DRAINAGE—continued					
Muskingum:	*Feet*			*Feet*	
Marietta, Ohio	36	(1)	2	40.4	1
Tuscarawas:					
Coshocton, Ohio	8	(1)	1		
Gnadenhutten, Ohio	10	(1)	2	13.1	Mar. 31
Scioto:					
Chillicothe, Ohio	16	(1)	1		
Wabash:					
Lafayette, Ind	11	(1)	4	21.2	Mar. 31
		29	29	11.3	29
Terre Haute, Ind	16	(1)	6	20.0	2
Vincennes, Ind	14	2	10	18.6	6
Mount Carmel, Ill	16	1	10	21.6	7
White:					
Decker, Ind	18	5	7	19.5	6
White, East Fork:					
Seymour, Ind	10	(1)	1	11.0	1
White, West Fork:					
Elliston, Ind	19	(1)	4	23.9	2
Edwardsport, Ind	14	(1)	6	18.6	3, 4
French Broad:					
Penrose, N. C	13	19	19	13.6	19
Wisconsin:					
Knowlton, Wis	12	17	19	14.8	18
		27	27	12.5	27
Illinois:					
Morris, Ill	13	(1)	5	15.8	Mar. 31
Peru, Ill	14	(1)	28	19.5	3
Henry, Ill	7	(1)	(2)	13.5	5
Peoria, Ill	16	(1)	26	20.1	6
Havana, Ill	14	(1)	24	16.5	7–9
Beardstown, Ill	12	(1)	(2)	17.6	9
Pearl, Ill	12	1	21	14.0	10–12
Meramec:					
Pacific, Mo	11	11	11	11.9	11
Valley Park, Mo	14	11	11	11.0	11
Arkansas:					
Wichita, Kans	9	30	(2)		
Little Arkansas:					
Sedgwick, Kans	18	29	(2)	22.7	29
Petit Jean:					
Danville, Ark	20	30	(2)		
North Platte:					
North Platte, Neb	5	19	21	5.5	19
		24	26	5.0	24–26
		29	29	5.2	29
Grand:					
Chillicothe, Mo	18	(1)	(2)	21.3	Mar. 31
Brunswick, Mo	10	16	19	10.3	17, 18
WEST GULF DRAINAGE					
Trinity:					
Dallas, Tex	25	27	(2)	[4] 31.0	28
Long Lake, Tex	40	(1)	3	40.4	2
Liberty	25	10	13	25.2	13
Rio Grande:					
San Marcial, N. Mex	2	1	1	2.0	1
		7	(2)	4.1	27–29
COLORADO DRAINAGE					
Colorado:					
Lees Ferry, Ariz	12	12	19	12.8	18
Parker, Ariz	7	15	25	7.5	20, 22
		29	30	7.0	29, 30

[1] Continued from last month.
[2] Continued at end of month.
[3] Below flood stage 8 a. m., April 1.
[4] Estimated.

MEAN LAKE LEVELS DURING APRIL, 1924

By UNITED STATES LAKE SURVEY

[Detroit, Mich., May 5, 1924]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during April, 1924:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	601.02	578.87	571.77	245.36
Above or below—				
Mean stage of March, 1924	−0.05	+0.18	+0.51	+0.48
Mean stage of April, 1923	−0.37	−0.33	+0.28	+0.03
Average stage for April last 10 years	−0.77	−1.40	−0.45	−0.78
Highest recorded April stage	−1.67	−4.36	−2.41	−3.07
Lowest recorded April stage	+0.48	−0.33	+0.51	+0.52
Average relation of the April level to:				
March level		+0.3	+0.6	+0.7
May level		−0.3	−0.4	−0.3

[1] Lake St. Clair's level: In April, 1924, 574.15 feet.

EFFECT OF WEATHER ON CROPS AND FARM OPERATIONS, APRIL, 1924

By J. B. KINCER

The weather during April was somewhat more favorable for agricultural interests than that for the preceding month, although the season continued considerably late in practically all sections east of the Mississippi River, and the frequent rains were unfavorable for field operations in the more eastern States. There was in general sufficient soil moisture in the central and eastern portions of the country, although part of the month was too dry in the region between the upper Mississippi Valley and the Rocky Mountains; rains in this section, however, improved conditions during the latter part of the month. But little rain fell west of the Rocky Mountains, and drought had become severe in much of that area at the close of the month, while frost damage to fruit was rather extensive, especially in the eastern portions of the North Pacific States.

Winter wheat made satisfactory progress during the month in the Ohio Valley States, except those portions where there was heavy winterkilling, while good wheat-growing weather was the rule in the trans-Mississippi States. Wheat plants were jointing as far north as southeastern Kansas at the close of the month. In the more northwestern States, and in California, the continued dry weather was decidedly unfavorable for wheat and other fall-sown grains. Conditions were rather favorable for seeding spring wheat, and this crop had been largely sown at the close of the month, while satisfactory germination of the early-sown grain was reported.

Much corn ground was prepared for seeding in the upper Mississippi and Ohio Valleys, but little had been seeded at the close of the month, though planting was general in Missouri, and was well along in the southern half of Kansas. Early-planted corn germinated satisfactorily in southern portions of the belt, while the crop did fairly well in the more southern States, although it was rather too cool in the south Atlantic area. In general the weather was favorable for cotton planting and this work was extended to the northern portions of the belt in all sections, though the latter part of the month was too cool and wet in many northern cotton districts. Most of the crop was seeded in the central and southern portions of the east Gulf States and planting was well along in Tennessee, with chopping progressing in the southern parts of Alabama and Georgia. The nights were too cool, however, the latter part of the month for best germination and growth of cotton in the eastern portions of the belt.

Potatoes did well under favorable conditions for this crop in the Southeastern States, though growth was rather slow; the weather was unfavorable for planting potatoes in the middle Atlantic coast sections.. Melons were backward and mostly poor in Florida, but tomatoes made good advance, with shipments in progress from the southern portions of the State. The warmer weather early in the month cleared the snow from most of the winter ranges in the Rocky Mountain districts and conditions were generally favorable for stock interests from that area eastward. Ranges were unfavorably affected by the dry weather in the more western States.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, April, 1924

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	63.3	−0.1	2 stations	90	[2] 21	St. Bernard	22	2	5.58	+1.19	Mentone	10.18	Bay Minette	2.29
Alaska														
Arizona	55.7	−2.4	2 stations	98	30	Prescott	11	16	0.71	+0.12	Cosino	2.40	Bisbee Junction	T.
Arkansas	61.4	+0.6	3 stations	94	14	2 stations	18	1	4.99	+0.21	Waldron	8.53	Mountain Home	2.92
California	57.1	+0.4	Needles	101	30	Helm Creek	−2	2	0.90	−0.78	Seven Oaks	4.57	2 stations	0.00
Colorado	42.0	−1.0	2 stations	90	23	Fraser	−26	1	1.31	−0.63	Hawthorne	4.13	Fruita	T.
Florida	70.8	+0.6	2 stations	96	[2] 12	Quincy	34	3	3.24	+0.73	Ocala	7.55	Sand Key	0.01
Georgia	63.2	−0.2	3 stations	90	[2] 17	Blue Ridge	23	[2] 2	5.99	+2.43	Clayton	10.49	St. George	2.47
Hawaii	70.4	+0.5	Kipahulu	88	2	Volcano Observatory	46	1	13.98	+5.75	Honomu	48.59	Puuloa	1.77
Idaho	44.6	−0.2	2 stations	84	30	Stanley	−4	5	0.51	−0.96	Pete King Ranger Station.	2.81	2 stations	0.00
Illinois	54.0	+2.2	Harrisburg	90	16	Dixon	14	1	2.18	−1.23	Tuscola	4.30	Hillsboro	0.65
Indiana	52.6	+0.9	Vincennes	91	25	Laporte	16	1	3.32	−0.30	Columbus	5.83	Frankfort	0.75
Iowa	50.5	+1.8	2 stations	90	[2] 15	Inwood	−8	1	1.38	−1.48	Belmond	4.53	Harlan	0.38
Kansas	55.0	+1.4	3 stations	93	[2] 15	2 stations	15	1	2.22	−0.42	Newton	7.32	Dresden	0.06
Kentucky	57.4	+1.5	Mayfield	93	15	Greenville	19	2	3.41	−0.62	Leitchfield	6.25	Ravenna	1.76
Louisiana	67.2	+0.3	Natchitoches	92	15	2 stations	29	[2] 1	4.41	−0.31	Lake Charles	12.24	Delta Farms	0.80
Maryland-Delaware	50.1	−2.2	2 stations	83	14	Oakland, Md	13	3	4.97	+1.63	Milford, Del	7.05	Friendsville, Md	2.76
Michigan	41.6	−0.6	Allegan	80	24	Humboldt	−27	1	2.14	−0.19	Ironwood	7.08	Mackinaw	0.45
Minnesota	41.5	−1.2	4 stations	88	[2] 21	Itasca State Park	−7	10	2.54	+0.53	Hallock	5.50	Waseca	0.55
Mississippi	64.6	+0.4	10 stations	90	[2] 15	Pontotoc	26	2	5.04	−0.37	Water Valley	8.38	Columbia	1.42
Missouri	56.6	+1.5	Hollister	95	14	Bethany	11	1	2.07	−1.66	Dean	6.32	Kidder	0.48
Montana	41.1	−1.3	Livingston	80	21	Babb	−3	15	0.79	−0.26	Agricultural College	2.82	Kalispell	0.01
Nebraska	50.1	+1.3	Bridgeport	95	23	Stanton	−2	1	0.72	−1.72	Beatrice	2.62	Watertown	0.02
Nevada	48.6	+0.3	Logandale	94	30	Rye Patch	7	16	0.30	−0.52	Austin	0.87	2 stations	0.00
New England	41.6	−1.2	Norwalk, Conn	74	27	Van Buren, Me	−2	4	4.92	+1.76	Madison, Me	7.36	Eastport, Me	2.29
New Jersey	48.0	−1.5	2 stations	81	[2] 14	Culvers Lake	18	1	6.15	+2.50	Chatham	9.23	Paterson	4.74
New Mexico	50.0	−0.9	Richland	93	24	2 stations	−9	17	0.75	−0.44	Tajique (near)	3.35	2 stations	0.00
New York	42.7	−1.6	West Point	80	29	North Lake	−3	3	4.60	+1.80	Boyds Corners	7.56	New Berlin	2.05
North Carolina	56.6	−0.7	2 stations	92	25	Mount Mitchell	5	2	4.44	+0.84	Rock House	11.03	Belhaven	1.31
North Dakota	39.3	−2.4	Lisbon	84	24	Pettibone	6	10	2.55	+1.17	Park River	5.91	Bottineau	0.50
Ohio	49.8	−0.3	Chillicothe	90	14	Kenton	17	2	2.71	−0.47	Cadiz	4.44	Dublin	1.26
Oklahoma	60.0	+0.3	Waurika	95	15	4 stations	22	1	4.21	+0.91	Muskogee	7.25	Kenton	0.74
Oregon	48.7	+1.1	McMinnville	91	25	Fremont	4	26	0.74	−1.41	Welches (near)	3.76	5 stations	0.00
Pennsylvania	46.5	−2.1	2 stations	82	[2] 27	Muncy Valley	6	3	4.15	+0.80	Conshohocken	7.52	Westford	1.77
Porto Rico	76.5	+1.3	Guayabal Reservoir	97	6	Jayuya	52	21	4.59	−0.19	Lares	17.72	Potala	0.00
South Carolina	61.6	−0.7	Blackville	91	9	3 stations	24	2	5.90	+2.84	Trenton	10.54	Mars Bluff	3.20
South Dakota	45.1	−0.3	Forestburg	93	22	Canton	−6	1	1.14	−0.74	Victor	3.70	Cottonwood	0.06
Tennessee	58.7	+0.4	Johnsonville	94	16	Crossville	17	2	4.75	+0.14	Chattanooga	10.43	Paris	1.95
Texas	65.6	−0.5	San Benito	107	16	2 stations	21	17	2.33	−0.89	Bon Wier	8.85	5 stations	0.00
Utah	46.2	−1.3	2 stations	89	[2] 6	Manila	2	1	0.52	−0.63	Silver Lake	2.55	2 stations	0.00
Virginia	52.6	−1.9	Hopewell	86	14	Burkes Garden	16	3	3.73	+0.18	Callaville	6.67	Mount Weather	1.29
Washington	47.9	−0.2	Wahluke	85	30	Paradise Inn	2	15	1.11	−1.13	Forks	6.44	12 stations	0.00
West Virginia	50.5	−0.8	Glenville	88	17	Cheat Bridge	12	3	3.24	−0.36	Crawford	6.37	Upper Tract	0.72
Wisconsin	42.0	−1.4	Brodhead	84	24	Minocqua	−28	1	3.95	+1.44	Stevens Point	7.14	Lancaster	1.37
Wyoming	39.4	−1.3	Clearmont	86	23	Gallatin	−10	16	0.94	−0.61	Elk Mountain	4.30	2 stations	T.

[1] For description of tables and charts, see REVIEW, January, 1924, pp. 56-57.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, April, 1924*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		°*F*	°*F.*		°*F*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**43.5**	**−0.3**										**73**	**4.73**	**+1.7**										**5.7**		
Eastport	76	67	85	29.85	29.94	+.01	37.4	−1.6	58	27	43	24	3	32	25	34	31	79	2.29	−0.6	12	9,735	s.	57	e.	2	2	10	18	7.5	12.1	0.0
Greenville, Me	1,070	6	----	28.76	29.94	----	35.6	----	59	29	44	16	4	27	35	----	----	----	4.45	----	9	----	se.	----	----	----	7	7	16	----	27.2	----
Portland, Me	103	82	117	29.83	29.96	.00	42.3	−0.7	66	27	49	25	2	35	22	38	32	70	6.48	+3.4	11	8,326	nw.	52	e.	7	9	8	13	5.8	7.7	0.0
Concord	288	70	79	29.62	29.93	−.06	42.9	−0.4	66	27	52	23	1	34	38	----	----	----	4.64	+1.8	9	5,366	nw.	44	e.	7	12	9	9	5.2	6.9	0.0
Burlington	404	11	48	29.51	29.96	−.03	41.0	+0.3	68	29	48	18	3	34	29	----	----	----	4.73	+2.9	15	7,638	n.	40	s.	6	5	9	16	7.1	19.1	0.0
Northfield	876	12	60	28.99	29.96	−.03	38.8	−1.4	65	29	48	16	1	29	41	36	32	78	4.35	+2.3	12	5,862	s.	38	s.	30	5	8	17	7.2	25.3	0.0
Boston	125	115	188	29.80	29.94	−.03	47.2	+0.8	69	27	55	28	1	40	27	40	33	62	3.79	+0.2	12	8,246	w.	42	e.	7	6	15	9	6.0	3.0	0.0
Nantucket	12	14	90	29.92	29.93	−.04	44.1	−0.1	63	27	50	32	1	38	21	40	37	81	4.30	+1.7	11	13,407	sw.	60	sw.	2	10	11	9	4.8	0.0	0.0
Block Island	26	11	46	29.90	29.93	−.05	43.8	−0.2	61	14	49	29	1	39	20	40	37	82	4.55	+0.9	15	14,219	sw.	60	w.	2	13	9	8	4.3	1.0	0.0
Providence	160	215	251	29.77	29.94	−.04	46.4	−0.2	68	5	55	26	1	38	29	40	33	64	3.77	0.0	15	11,633	nw.	60	se.	7	9	12	9	5.4	3.0	0.0
Hartford	159	122	140	29.78	29.96	−.03	47.3	+0.6	70	28	56	24	1	38	29	----	----	----	5.92	+2.4	12	----	nw.	----	----	----	12	7	11	5.0	9.7	0.0
New Haven	106	74	153	29.84	29.95	−.04	47.2	0.0	71	27	55	25	1	39	27	41	34	65	7.17	+3.6	12	7,691	n.	27	se.	30	12	8	10	4.9	7.8	0.0
Middle Atlantic States							**50.1**	**−1.1**										**67**	**4.66**	**+1.5**										**5.2**		
Albany	97	102	115	29.86	29.97	−.03	45.2	−1.6	71	27	54	21	1	37	32	40	33	66	5.23	+2.8	14	6,043	s.	32	se.	6	15	4	11	4.9	14.0	0.0
Binghamton	871	10	84	29.02	29.97	−.05	44.4	0.0	74	28	54	21	3	35	38	----	----	----	3.85	+1.6	14	4,922	nw.	29	sw.	22	6	9	15	6.5	10.0	0.0
New York	314	414	454	29.62	29.96	−.04	48.1	−1.3	71	27	56	26	2	41	26	42	35	65	4.53	+1.2	9	14,981	nw.	66	nw	7	8	10	12	6.1	8.0	0.0
Harrisburg	374	94	104	29.59	30.00	−.02	49.4	−1.5	73	14	58	26	1	41	28	42	34	60	5.15	+2.7	11	5,341	nw.	42	nw.	20	12	6	12	5.3	8.0	0.0
Philadelphia	114	123	190	29.86	29.99	−.02	51.2	−0.9	76	14	60	27	2	43	26	43	34	56	5.37	+2.5	11	7,264	w.	34	n.	22	12	4	14	5.7	6.7	0.0
Reading	325	81	98	29.62	29.98	----	49.0	----	76	28	58	25	2	40	31	45	42	77	5.34	+2.1	11	3,609	nw.	28	nw.	20	15	9	6	4.5	10.0	0.0
Scranton	805	111	119	29.11	29.98	−.03	46.2	−0.9	77	28	56	22	1	37	39	43	41	85	3.30	+0.6	10	5,729	nw.	36	sw.	22	9	9	12	6.1	7.0	0.0
Atlantic City	52	37	172	29.92	29.98	−.02	48.8	+1.0	77	14	56	29	2	42	30	43	38	70	5.39	+2.4	12	14,267	w.	70	ne.	1	12	9	9	4.5	T.	0.0
Cape May	17	13	49	30.00	30.02	+.03	49.8	+1.4	78	14	57	32	1	43	30	44	40	75	5.60	+2.6	13	7,462	nw.	38	ne.	1	12	7	11	5.0	0.3	0.0
Sandy Hook	22	10	55	29.94	29.96	----	47.6	----	69	27	54	27	2	41	24	42	36	69	4.98	----	11	12,095	w.	50	nw.	7	9	11	10	5.6	2.4	0.0
Trenton	190	159	183	29.78	29.98	----	49.4	----	76	28	59	23	2	40	28	42	36	64	5.99	+2.7	12	9,353	nw.	50	nw.	22	10	10	10	5.2	7.5	0.0
Baltimore	123	100	113	29.86	29.99	−.02	52.2	−1.4	80	14	61	28	2	44	27	45	37	62	5.89	+2.6	9	4,648	w.	28	sw.	20	13	7	10	5.2	9.4	0.0
Washington	112	62	85	29.88	30.00	−.02	51.9	−1.4	80	14	62	28	1	42	36	44	36	58	5.39	+2.1	9	5,514	nw.	46	nw.	20	10	11	9	5.2	5.0	0.0
Cape Henry	18	8	54	29.97	29.99	----	53.4	----	80	22	61	32	2	46	28	49	45	77	3.95	0.0	11	9,964	se.	50	nw.	1	14	6	10	5.1	0.0	0.0
Lynchburg	681	153	188	29.25	29.99	−.03	54.1	−3.2	84	14	66	31	3	42	40	46	39	62	3.35	+0.2	10	5,774	w.	44	n.	7	13	7	10	4.9	T.	0.0
Norfolk	91	170	205	29.91	30.01	.00	55.4	−1.4	82	14	65	33	2	46	29	48	42	65	2.89	−0.9	10	9,985	s.	47	nw.	1	12	6	12	5.2	0.0	0.0
Richmond	144	11	52	29.85	30.00	−.02	54.0	−2.6	82	14	65	27	3	43	34	47	39	62	5.11	+1.7	12	5,480	sw.	33	se.	22	15	9	6	3.8	T.	0.0
Wytheville	2,304	49	55	27.62	30.00	−.03	50.6	−1.4	78	24	61	23	3	40	42	44	39	70	2.83	−0.8	13	5,618	w.	42	w.	7	16	2	12	4.9	T.	0.0
South Atlantic States							**60.8**	**−1.0**										**72**	**4.30**	**+1.1**										**4.9**		
Asheville	2,255	70	84	27.66	30.02	−.01	53.3	−0.3	77	24	64	24	3	43	38	46	40	68	3.58	+0.4	15	6,888	nw.	36	s.	21	14	6	10	5.0	0.2	0.0
Charlotte	779	55	62	29.16	30.00	−.03	58.8	−1.0	85	25	70	29	2	48	32	51	44	66	6.78	+3.3	14	4,292	sw.	28	w.	20	11	9	10	5.1	0.0	0.0
Hatteras	11	11	50	29.99	30.00	−.01	56.9	−2.9	73	25	63	38	2	51	26	53	49	78	4.17	−0.2	11	11,553	sw.	54	nw.	1	13	8	9	4.3	0.0	0.0
Manteo	12	5	42	----	----	----	55.1	----	79	14	----	30	3	----	36	----	----	----	3.38	----	6	----	----	----	----	----	----	----	----	----	0.0	0.0
Raleigh	376	103	110	29.60	30.00	−.03	57.8	−1.6	86	25	69	31	2	47	33	51	45	69	3.08	−0.4	9	6,516	e.	39	nw.	20	13	5	12	5.0	0.0	0.0
Wilmington	78	81	91	29.93	30.02	−.01	60.8	−1.2	85	9	70	35	2	51	29	54	50	74	2.20	−0.7	10	6,334	sw.	35	sw.	30	17	2	11	4.3	0.0	0.0
Charleston	48	11	92	29.97	30.02	−.01	64.0	−0.5	86	8	71	41	2	57	28	57	54	77	5.78	+2.8	7	8,335	sw.	48	e.	15	12	8	10	5.2	0.0	0.0
Columbia, S. C	351	41	57	29.63	30.01	−.02	62.2	−1.1	85	8	72	33	2	52	31	56	51	73	6.66	+3.8	12	5,638	ne.	31	sw.	30	15	2	13	4.9	0.0	0.0
Due West	711	10	55	29.26	30.03	----	59.2	----	85	25	70	28	2	48	34	----	----	----	5.61	----	13	7,712	sw.	41	sw.	30	13	6	11	5.1	0.0	0.0
Greenville, S. C	1,039	113	122	28.90	29.99	----	58.8	+0.2	84	25	69	31	2	48	31	51	46	72	7.02	----	13	7,493	ne.	48	sw.	30	12	7	11	5.0	0.0	0.0
Augusta	180	62	77	29.81	30.00	−.03	63.4	−0.8	85	25	74	35	2	53	34	57	52	71	3.93	+0.4	9	4,520	nw.	27	sw.	30	14	6	10	4.6	0.0	0.0
Savannah	65	150	194	29.95	30.02	−.01	65.4	−0.6	84	29	74	40	2	57	27	58	54	75	3.87	+0.9	6	8,683	sw.	38	nw.	1	14	6	10	4.8	0.0	0.0
Jacksonville	43	209	245	29.97	30.02	−.02	67.7	−1.0	83	22	76	44	2	60	24	60	56	74	3.00	+0.3	8	8,793	sw.	54	sw.	30	9	12	9	5.6	0.0	0.0
Florida Peninsula							**75.0**	**+1.4**										**77**	**1.72**	**−0.4**										**4.2**		
Key West	22	10	64	29.97	29.99	−.03	78.0	+2.3	87	30	83	67	7	73	14	71	68	75	0.19	−1.1	3	6,745	se.	36	n.	15	21	8	1	2.8	0.0	0.0
Miami	25	71	79	30.00	30.02	----	74.6	+0.4	89	12	81	61	26	68	20	68	66	75	3.40	+0.1	6	5,638	e.	26	e.	4	7	12	11	5.6	0.0	0.0
Sand Key	23	39	72	29.98	30.01	−0.1	76.0	----	84	30	78	67	7	74	9	71	69	82	0.01	----	1	8,653	se.	38	n.	15	20	5	5	3.3	0.0	0.0
Tampa	35	79	87	29.98	30.02	−0.4	72.4	+1.4	88	17	81	53	3	64	24	65	61	75	1.56	−0.3	8	4,465	ne.	28	sw.	11	11	11	8	5.3	0.0	0.0
East Gulf States							**64.2**	**−0.5**										**73**	**5.32**	**+1.2**										**5.8**		
Atlanta	1,174	190	216	28.78	30.02	−.01	59.2	−1.8	83	25	68	29	2	50	26	53	48	71	7.76	+4.1	12	8,741	nw.	46	nw.	1	11	6	13	5.5	0.0	0.0
Macon	370	78	87	29.62	30.01	−.02	62.8	−1.1	86	25	74	33	2	52	36	55	49	66	5.40	+2.0	11	4,574	nw.	24	nw.	1	9	6	15	6.0	0.0	0.0
Thomasville	273	49	58	29.72	30.01	−.02	67.4	+0.7	87	26	78	39	2	57	29	59	54	68	5.06	+1.4	7	3,455	sw.	24	sw.	30	9	8	13	6.1	0.0	0.0
Apalachicola	36	42	49	29.97	30.01	----	66.4	----	79	22	72	45	2	61	19	62	59	82	2.72	----	8	5,609	sw.	38	se.	4	13	10	7	4.8	0.0	0.0
Pensacola	56	149	185	29.95	30.01	−.01	65.9	−0.8	83	22	71	40	1	61	21	61	59	83	4.26	+1.1	7	9,072	s.	47	sw.	30	5	10	15	6.3	0.0	0.0
Anniston	741	9	57	29.24	30.03	.00	60.2	−0.2	85	25	71	29	2	49	37	----	----	----	6.34	+2.7	13	4,084	se.	23	sw.	30	12	8	10	5.1	0.0	0.0
Birmingham	700	11	48	29.26	30.02	.00	62.0	−1.3	84	25	72	30	2	52	31	53	47	65	5.62	+2.0	12	5,166	n.	27	s.	29	11	10	9	5.0	0.0	0.0
Mobile	57	125	161	29.95	30.01	−.01	66.6	+0.4	84	22	74	38	1	59	23	61	58	80	4.10	−0.2	8	7,058	s.	38	se.	4	6	12	12	6.5	0.0	0.0
Montgomery	223	100	112	29.76	30.02	−.01	64.6	−0.7	85	26	74	36	2	55	28	57	51	67	6.18	+1.9	10	4,759	sw.	32	sw.	30	8	9	13	6.0	0.0	0.0
Corinth	469	6	----	----	----	----	62.4	----	90	16	74	28	2	51	37	----	----	----	6.10	----	9	----	se.	----	----	----	6	18	6	----	0.0	0.0
Meridian	375	85	93	29.60	30.00	−.02	63.4	−0.6	86	16	73	33	2	54	33	56	51	70	6.95	+1.9	10	4,016	ne.	26	w.	30	8	11	11	6.0	0.0	0.0
Vicksburg	247	65	74	29.73	30.01	+.01	65.3	−0.3	86	16	74	35	1	56	26	58	53	73	3.75	−1.4	12	4,949	se.	36	w.	29	6	8	16	6.3	0.0	0.0
New Orleans	53	76	84	29.95	30.00	.00	69.1	+0.3	85	15	77	42	1	61	22	63	60	78	3.10	−1.8	8	4,857	se.	28	ne.	1	5	11	14	6.2	0.0	0.0
West Gulf States							**65.6**	**−0.2**										**74**	**3.27**	**−0.2**										**5.9**		
Shreveport	249	77	93	29.70	29.97	.00	65.4	−0.4	89	15	75	38	1	56	29	58	53	70	2.87	−1.7	9	5,249	s.	32	s.	29	11	11	8	5.1	0.0	0.0
Bentonville	1,303	11	44	----	----	----	58.6	+1.7	87	15	70	28	1	48	31	----	----	----	6.19	----	6	4,612	s.	26	s.	16	16	4	10	----	0.0	0.0
Fort Smith	457	79	94	29.45	29.93	−.03	61.8	0.0	91	15	72	31	1	51	36	53	45	61	7.57	+3.7	7	6,551	e.	45	nw.	29	11	10	9	5.4	0.0	0.0
Little Rock	357	136	144	29.59	29.96	−.02	62.6	+0.5	88	15	72	31	1	53	32	54	47	64	5.43	+0.9	10	6,923	s.	46	nw.	25	10	9	11	5.6	0.0	0.0
Brownsville	57	53	61	29.84	29.90	----	73.6	----	92	16	81	48	1	66	25	66	64	82	0.11	----	2	6,535	s.	28	s.	25	5	18	7	5.5	0.0	0.0
Corpus Christi	20	11	73	29.92	29.94	−.01	70.5	−0.4	86	29	76	46	1	65	20	66	63	82	0.10	−1.7	2	10,068	se.	42	se.	25	3	10	17	7.3	0.0	0.0
Dallas	512	109	117	29.41	29.95	----	66.2	----	92	21	77	38	1	56	36	----	----	----	1.54	----	6	7,439	s.	44	nw.	29	9	12	9	5.4	0.0	0.0
Fort Worth	670	106	114	29.22	29.92	−.02	65.2	−0.1	93	21	76	36	1	54	35	56	51	65	2.33	−0.3	4	7,719	s.	38	w.	29	11	9	10	5.0	0.0	0.0
Galveston	54	106	114	29.92	29.98	+.01	67.2	−1.5	77	30	71	47	1	63	16	63	62	88	1.14	−2.0	7	8,152	se.	48	se.	25	4	13	13	6.6	0.0	0.0
Groesbeck	461	11	56	29.46	29.94	----	65.3	----	87	29	75	34	1	55	38	----	----	----	1.86	----	6	8,539	s.	51	s.	25	9	4	17	6.0	0.0	0.0
Houston	138	111	121	29.82	29.97	----	68.8	−0.8	85	14	77	42	1	61	23	----	----	----	2.67	----	8	5,866	se.	31	se.	25	6	11	13	6.3	0.0	0.0
Palestine	510	64	72	29.43	29.96	.00	65.2	−0.8	86	14	75	36	1	56	30	58	54	72	2.66	−1.4	6	6,206	s.	32	nw.	29	7	14	9	5.7	0.0	0.0
Port Arthur	34	58	66	29.93	29.97	----	67.8	----	83	14	74	42	1	62	21	63	60	84	1.77	----	7	7,364	se.	36	se.	25	6	6	18	6.9	0.0	0.0
San Antonio	693	119	132	29.21	29.93	.00	69.2	+0.2	90	21	80	39	1	59	33	60	55	68	3.36	+0.4	7	5,955	se.	36	nw.	26	8	16	6	5.3	0.0	0.0
Taylor	583	55	63	29.36	29.97	+.02	66.8	−0.7	89	21	77	35	1	57	36	----	----	----	3.95	0.0	8	7,175	se.	34	se.	25	5	11	14	6.3	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, April, 1924*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Ohio Valley and Tennessee							55.0	+0.1										63	4.01	+0.4										6.0		
Chattanooga	762	189	213	29.20	30.01	−.02	58.8	−1.5	83	25	68	29	2	49	33	50	43	63	10.43	+6.0	12	6,145	n.	44	s.	21	10	10	10	5.3	0.0	0.0
Knoxville	996	102	111	28.94	30.00	−.03	58.0	0.0	81	24	68	31	2	48	36	50	43	64	5.46	+0.8	12	5,466	sw.	36	sw.	7	7	6	17	6.7	T.	0.0
Memphis	399	76	97	29.55	29.98	−.02	62.1	+0.3	88	16	70	31	1	54	26	54	47	64	4.74	−0.1	12	5,309	sw.	52	nw.	29	13	9	8	4.9	0.0	0.0
Nashville	546	168	191	29.42	30.01	.00	59.3	+0.3	84	25	69	25	2	49	35	51	43	60	3.55	−0.8	10	7,696	s.	51	nw.	26	13	7	10	4.8	0.0	0.0
Lexington	989	193	230	28.92	30.00	−.02	54.9	+0.6	82	15	65	25	1	45	35				3.75	+0.4	14	10,333	sw.	58	sw.	21	8	12	10	5.7	T.	0.0
Louisville	525	219	255	29.41	30.00	−.01	57.0	+0.6	83	16	67	28	1	47	37	48	41	60	3.29	−0.8	12	7,847	s.	55	sw.	21	10	9	11	5.5	T.	0.0
Evansville	431	139	175	29.52	29.99	−.01	58.4	+0.7	86	16	68	28	2	49	32	50	42	61	3.49	0.0	12	8,361	sw.	47	sw.	21	6	17	7	5.8	T.	0.0
Indianapolis	822	194	230	29.08	29.97	−.03	53.4	+1.3	82	16	63	25	1	44	31	46	39	64	3.28	−0.2	11	9,214	s.	50	w.	7	5	18	7	5.7	2.0	0.0
Royal Center	736	11	55	29.16	29.96	.....	48.6	.....	78	24	60	20	1	37	38	.....	.....	.....	3.36	.....	17	8,947	w.	44	nw.	7	3	10	17	7.6	1.0	0.0
Terre Haute	575	96	129	29.34	29.96	.....	55.1	.....	82	16	65	26	1	45	32	47	40	63	2.16	.....	11	7,767	s.	34	sw.	19	6	12	12	6.2	0.2	0.0
Cincinnati	628	11	51	29.30	29.98	−.03	53.8	+1.4	82	16	65	25	1	43	40	.....	41	63	2.40	−0.6	13	6,003	sw.	40	w.	7	7	11	12	6.1	0.9	0.0
Columbus	824	179	222	29.10	29.98	−.04	51.2	0.0	76	24	61	25	1	41	39	45	40	70	3.12	+0.2	11	8,320	w.	43	nw.	7	9	10	11	6.1	1.0	0.0
Dayton	899	137	173	29.01	29.97	.....	52.2	+0.5	80	16	63	26	2	42	36	45	37	60	2.20	−0.7	11	7,479	sw.	50	nw.	7	6	14	10	5.5	3.0	0.0
Elkins	1,947	59	67	27.93	30.00	−.03	47.6	−1.2	75	16	60	18	3	35	43	42	36	70	4.15	+0.9	16	4,573	w.	41	w.	20	4	10	16	7.2	3.9	0.0
Parkersburg	638	77	84	29.34	30.00	−.03	53.6	+0.2	82	21	65	28	3	42	46	45	37	60	3.24	+0.3	12	4,508	sw.	46	nw.	6	9	7	14	6.1	4.7	0.0
Pittsburgh	842	353	410	29.07	29.98	−.04	49.8	−1.4	72	24	59	26	2	40	31	42	34	60	3.09	+0.2	15	8,188	w.	46	w.	20	7	7	16	6.7	3.2	0.0
Lower Lake Region							44.3	−1.2										70	3.23	+0.9										6.0		
Buffalo	767	247	280	29.14	29.98	−.03	41.1	−1.7	68	28	48	21	1	34	28	37	32	76	3.08	+0.6	12	11,567	sw.	52	sw.	22	10	9	11	5.6	4.1	0.0
Canton	448	10	61	29.46	29.94	.....	40.5	−2.0	67	27	49	10	1	32	35	.....	.....	.....	3.32	+1.1	15	7,732	w.	32	sw.	10	11	8	11	5.3	7.7	0.0
Oswego	335	76	91	.....	29.97	−.04	41.4	−2.2	64	4	48	22	1	35	29	.....	.....	75	4.34	+2.1	13	.....	w.	30	nw.	2	8	7	15	.....	3.8	0.0
Rochester	523	86	102	29.40	29.99	−.02	43.4	−1.5	68	28	51	23	1	36	29	38	31	65	4.05	+1.6	12	6,298	w.	36	sw.	22	9	9	12	5.7	7.8	0.0
Syracuse	597	97	113	29.34	29.99	−.02	43.2	−1.2	67	28	51	23	1	36	25	.....	.....	.....	3.87	+1.6	12	9,073	nw.	45	nw.	23	6	11	13	6.2	6.8	0.0
Erie	714	130	166	29.19	29.97	−.05	44.4	−0.7	66	13	51	24	1	37	25	40	34	68	3.70	+1.3	17	10,198	w.	48	se.	17	8	8	14	6.3	1.4	0.0
Cleveland	762	190	201	29.14	29.98	−.04	45.3	−0.9	70	13	53	24	1	38	26	40	34	65	2.85	+0.5	15	9,273	w.	39	w.	20	3	17	10	6.7	0.7	0.0
Sandusky	629	62	70	29.28	29.98	−.04	46.4	−0.8	72	13	54	25	1	39	29	.....	.....	.....	2.93	+0.4	13	6,542	e.	31	nw.	18	2	17	11	6.6	2.4	0.0
Toledo	628	208	243	29.29	29.98	−.03	46.8	−0.8	74	24	55	22	1	39	29	42	37	73	2.22	−0.1	12	11,066	sw.	39	sw.	13	10	12	8	5.3	1.6	0.0
Fort Wayne	856	113	124	29.04	29.97	.....	48.5	−0.8	76	24	58	23	1	39	31	42	38	72	2.79	.....	14	7,234	e.	35	w.	7	6	14	10	6.1	6.7	0.0
Detroit	730	218	258	29.18	29.98	−.04	46.0	−0.2	74	24	54	20	1	38	32	39	33	65	1.97	−0.4	17	8,740	sw.	33	sw.	13	7	13	10	5.8	0.8	0.0
Upper Lake Region							41.2	−0.3										72	2.24	−0.1										6.2		
Alpena	609	13	92	29.30	29.98	−.04	38.4	−0.2	64	29	47	6	1	30	34	35	29	67	1.45	−0.8	9	8,491	w.	36	nw.	22	5	12	13	6.6	4.3	0.0
Escanaba	612	54	60	29.28	29.96	−.06	37.4	−0.5	59	27	45	2	1	30	30	33	28	74	3.03	+1.0	13	6,671	s.	40	e.	16	6	14	10	5.5	6.6	0.0
Grand Haven	632	54	89	29.26	29.95	−.06	43.2	−0.5	73	24	50	20	1	36	28	39	35	76	3.08	+0.6	13	8,624	e.	36	w.	6	4	16	10	6.1	0.4	0.0
Grand Rapids	707	70	87	29.19	29.97	−.05	45.6	−0.6	72	24	54	20	1	37	26	39	33	66	3.29	+0.8	13	5,392	w.	25	w.	6	6	9	15	6.3	4.0	0.0
Houghton	668	62	99	29.19	29.93	−.09	36.3	−1.4	58	28	43	3	1	29	30	.....	.....	.....	1.48	−0.6	15	8,840	e.	44	w.	9	9	6	15	6.6	4.3	0.0
Lansing	878	11	62	29.01	29.96	.....	44.6	−1.0	73	24	55	20	2	34	32	39	33	68	2.46	−0.1	13	5,142	w.	22	w.	9	3	17	10	5.9	4.0	0.0
Ludington	637	60	66	29.24	29.95	.....	41.4	.....	69	27	48	18	1	35	26	37	33	76	3.03	.....	17	8,157	s.	34	se.	16	7	13	10	5.6	2.5	0.0
Marquette	734	77	111	29.16	29.98	−.04	36.6	−0.9	59	3	43	6	1	30	31	33	27	71	1.57	−0.4	13	6,733	nw.	29	w.	12	5	10	15	7.2	5.3	0.0
Port Huron	638	70	120	29.26	29.96	−.06	43.5	+0.5	68	13	52	19	2	35	29	38	32	70	1.41	−0.7	11	8,421	nw.	32	nw.	9	5	17	8	5.6	3.5	0.0
Saginaw	641	69	77	29.27	29.97	.....	43.8	−1.1	69	29	54	15	2	34	30	38	33	68	0.91	−1.8	11	7,028	w.	29	se.	21	2	12	16	6.9	1.3	0.0
Sault Sainte Marie	614	11	52	29.28	29.98	−.03	36.5	−0.9	66	27	45	5	1	28	33	32	27	73	1.59	−0.5	11	6,876	nw.	34	nw.	12	9	13	8	5.4	4.9	0.0
Chicago	823	140	310	29.06	29.96	−.04	49.0	+1.3	76	24	56	23	1	42	26	42	36	65	0.84	−2.0	9	7,899	w.	37	nw.	7	6	13	11	6.3	0.4	0.0
Green Bay	617	109	144	29.25	29.92	−.09	41.8	+1.1	67	13	50	11	1	34	24	37	33	77	4.64	+2.2	14	8,521	w.	36	ne.	25	3	15	12	6.4	1.9	0.0
Milwaukee	681	125	139	29.19	29.94	−.05	44.1	+0.3	72	13	51	20	1	37	29	39	35	75	2.64	−0.1	14	7,904	w	33	e.	26	7	8	15	6.4	0.4	0.0
Duluth	1,133	11	47	28.66	29.90	−.11	36.6	−0.4	61	3	44	13	1	29	32	32	27	75	2.96	+0.8	14	11,559	ne.	46	ne.	26	5	13	12	6.3	9.0	0.0
North Dakota							39.7	−1.0										72	3.07	+1.2										7.0		
Moorhead	940	50	58	28.83	29.87	−.12	41.0	+0.4	76	23	51	12	1	31	40	36	30	68	4.01	+1.7	14	7,668	nw.	42	se.	15	5	15	10	6.2	2.6	0.0
Bismarck	1,674	8	57	28.12	29.93	−.04	41.0	−1.1	74	23	52	17	1	30	40	35	30	73	1.90	0.0	11	8,237	nw.	44	n.	24	4	7	19	7.7	13.4	0.0
Devils Lake	1,478	11	44	28.28	29.88	−.11	37.1	−1.1	63	22	46	15	12	28	36	33	28	76	4.96	+2.9	13	8,732	nw.	44	n.	24	6	8	16	7.0	9.1	0.0
Ellendale	1,457	10	56	28.31	29.89	.....	42.2	.....	79	24	55	12	1	30	45	.....	.....	.....	2.63	.....	13	12,323	nw.	60	nw.	24	4	10	16	6.9	1.9	0.0
Grand Forks	835	12	89	.....	.....	.....	38.8	.....	68	23	49	14	12	29	38	.....	.....	.....	3.95	.....	14	.....	nw.	36	se.	24	6	9	15	.....	3.2	0.0
Williston	1,878	41	48	27.90	29.91	−.05	39.7	−2.3	69	23	49	21	10	30	37	34	29	70	1.40	+0.2	10	6,376	nw.	37	w.	6	3	11	16	7.0	8.2	0.0
Upper Mississippi Valley							52.0	+1.5										65	2.08	−0.9										5.7		
Minneapolis	918	102	208	28.87	29.86	.....	44.2	.....	79	24	53	10	1	35	34	.....	.....	.....	3.38	+0.9	17	9,996	nw.	40	se.	26	6	9	15	6.7	2.0	0.0
St. Paul	837	236	261	28.96	29.88	−.11	43.6	−2.0	76	23	52	6	1	35	32	.....	.....	.....	3.32	+1.0	18	11,115	nw.	47	se.	26	8	6	16	6.4	1.3	0.0
La Crosse	714	11	48	29.12	29.90	−.08	47.0	−0.2	81	24	57	7	1	37	32	.....	.....	.....	2.24	0.0	13	4,637	w.	21	e.	16	5	13	12	6.6	T.	0.0
Madison	974	70	78	28.87	29.94	−.05	45.2	−0.2	76	24	53	17	1	37	28	40	36	76	3.25	+0.9	9	7,347	nw.	28	ne.	14	6	12	12	6.3	0.1	0.0
Wausau	1,247	4	.....	28.57	29.93	.....	38.6	.....	63	23	46	3	1	31	28	.....	.....	.....	5.97	.....	15	.....	w.	.....	.....	.....	8	5	17	6.5	4.5	0.0
Charles City	1,015	10	49	28.82	29.90	−.08	47.7	+1.4	83	24	58	15	1	37	34	41	36	68	1.20	−1.6	9	6,268	se.	30	sw.	16	11	12	7	4.9	2.0	0.0
Davenport	606	71	79	29.26	29.92	−.06	52.2	+2.3	84	24	62	26	2	42	36	46	41	70	1.11	−1.8	10	6,185	s.	30	sw.	16	8	12	10	5.4	1.0	0.0
Des Moines	861	84	97	28.98	29.90	−.07	52.3	+2.2	84	24	63	16	1	42	34	45	38	62	0.78	−2.2	10	5,903	sw.	30	sw.	3	12	8	10	5.2	0.3	0.0
Dubuque	700	81	96	29.14	29.90	−.08	49.4	+0.8	82	24	59	21	1	40	30	42	36	64	1.12	−1.8	9	5,483	nw.	25	se.	16	12	5	13	5.9	0.8	0.0
Keokuk	614	64	78	29.26	29.93	−.05	55.0	+2.7	86	16	66	22	1	44	36	47	40	60	2.07	−1.3	8	6,476	w.	35	nw.	21	9	7	14	5.5	T.	0.0
Cairo	358	87	93	29.58	29.96	−.02	59.7	+1.6	87	16	69	26	1	50	34	50	43	60	2.49	−1.1	11	6,869	s.	34	sw.	21	6	11	13	5.8	T.	0.0
Peoria	609	11	45	29.28	29.94	−.05	53.5	+2.6	86	16	65	22	1	42	36	46	40	67	2.13	−1.2	10	5,596	s.	30	w.	19	13	10	7	4.4	0.4	0.0
Springfield, Ill	636	10	91	29.25	29.92	−.06	55.9	+3.2	85	16	66	26	1	45	35	48	41	65	2.18	−1.1	12	6,157	s.	24	nw.	19	11	10	9	5.0	0.2	0.0
Hannibal	534	74	109	29.36	29.94	−.04	56.1	+2.7	86	24	67	22	1	45	37	.....	.....	.....	1.96	−1.3	10	6,922	sw.	38	sw.	19	9	10	11	5.5	T.	0.0
St. Louis	568	265	303	29.33	29.94	−.04	58.4	+2.6	86	16	68	25	1	49	32	49	43	62	1.90	−1.6	8	10,284	s.	61	s.	19	10	9	11	5.3	T.	0.0
Missouri Valley							52.3	+1.4										61	1.53	−1.4										4.7		
Columbia, Mo	784	11	84	29.10	29.94	−.04	56.6	+1.7	87	15	68	21	1	45	37	.....	.....	.....	1.46	−2.2	6	6,312	s.	31	sw.	19	12	7	11	5.4	T.	0.0
Kansas City	963	161	181	28.88	29.92	−.04	56.8	+2.0	88	15	67	24	1	47	32	48	40	58	1.38	−1.9	7	8,099	s.	35	sw.	16	12	11	7	4.5	0.0	0.0
St. Joseph	967	11	49	28.87	29.90	.....	55.8	.....	88	15	67	20	1	44	36	46	37	57	0.62	.....	5	6,869	nw.	33	nw.	19	15	9	6	4.1	0.0	0.0
Springfield, Mo	1,324	98	104	28.54	29.95	−.02	56.2	+0.2	87	15	66	24	1	47	31	48	41	61	3.22	−0.6	10	8,287	se.	41	sw.	19	16	7	7	3.9	0.0	0.0
Iola	984	11	50	28.87	29.91	−.04	57.0	+2.8	89	15	69	22	1	45	37	.....	.....	.....	2.77	0.0	10	5,490	s.	27	n.	29	15	8	7	4.3	0.0	0.0
Topeka	987	92	107	.....	.....	.....	56.2	+1.5	90	15	68	22	1	44	36	.....	.....	.....	1.80	−0.9	7	8,083	sw.	35	sw.	24	12	11	7	4.5	0.0	0.0
Drexel	1,299	10	54	28.50	29.90	.....	50.9	.....	86	15	63	14	1	39	37	.....	.....	.....	1.31	.....	6	9,303	s.	38	nw.	19	11	10	9	5.1	0.0	0.0
Linclon	1,189	11	84	28.63	29.90	−.04	53.6	+2.1	91	15	66	19	1	42	37	44	36	59	1.54	−1.2	6	8,837	s.	42	nw.	19	10	10	10	5.7	0.0	0.0
Omaha	1,105	115	122	28.72	29.90	−.05	53.4	+2.2	86	15	64	17	1	43	38	44	35	56	0.94	−2.1	7	6,620	nw.	38	n.	8	10	14	6	4.8	0.0	0.0
Valentine	2,598	47	54	.....	29.88	−.06	46.8	+1.1	86	23	61	20	1	33	46	.....	.....	60	0.32	−2.0	8	8,540	w.	38	nw.	24	12	11	7	.....	1.6	0.0
Sioux City	1,135	94	164	28.68	29.90	−.05	49.8	+2.0	88	14	61	8	1	38	40	42	35	62	1.16	−1.6	8	10,405	nw.	45	nw.	19	11	13	6	4.7	0.1	0.0
Huron	1,306	59	74	28.48	29.89	−.07	45.4	+0.2	86	23	59	5	1	32	49	39	32	68	0.92	−1.7	7	8,283	w.	36	nw.	16	13	12	5	4.2	3.0	0.0
Pierre	1,572	70	75	28.20	29.88	−.07	46.9	+0.1	88	23	59	12	1	34	46	39	31	64	0.99	−1.0	5	8,118	nw.	50	nw.	24	10	5	15	5.8	5.6	0.0
Yankton	1,233	49	57	28.57	29.89	−.06	49.0	+1.1	88	14	61	3	1	36	45	.....	.....	.....	1.81	−1.0	8	7,444	w.	32	nw.	19	13	11	6	4.7	0.1	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, April, 1924*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Northern Slope	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*° F.*	*° F.*	*°F*		*° F.*	*° F.*		*° F.*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Billings	3,140	5					42.4	−0.8										59	0.81	−0.8										6.2		
Havre	2,505	11	44	27.28	29.93	.00	44.8																									
Helena	4,110	87	112	25.75	29.98	+.01	42.8	−0.9	68	30	54	19	25	31	39	36	27	61	0.59		3											
Kalispell	2,973	48	56	26.89	29.97	+.01	42.2	−1.3	69	30	51	21	25	33	38	34	23	51	1.00	0.0	7	6,528	nw.				9	7	14			
Miles City	2,371	48	55	27.42	29.99	+.03	42.9	−0.7	65	26	53	21	25	32	40	35	23	50	0.50	−0.6	8	7,150	e.	36	nw.	18	7	16	7	5.4	1.4	0.0
Rapid City	3,259	50	58	26.51	29.96	+.01	44.2	−0.5	71	22	53	28	1	36	32	38	30	63	0.01	−1.0	1	4,941	sw.	44	sw.	18	3	8	19	7.6	2.1	0.0
Cheyenne	6,088	84	101	23.91	29.93	+.02	44.1	−0.2	77	22	56	18	1	32	44	36	28	56	1.31	+0.1	10	5,781	sw.	35	sw.	14	8	10	12	5.9	0.1	0.0
Lander	5,372	60	68	24.57	29.96	+.02	39.4	−1.5	70	23	51	12	26	28	34	33	26	63	0.34	−2.0	5	7,589	nw.	36	nw.	17	2	11	17	7.0	0.7	0.0
Sheridan	3,790	10	47	26.04	29.99		40.5	−1.9	69	22	52	14	1	29	34	33	25	61	1.41	−0.4	9	10,000	w.	46	nw.	24	4	16	10	6.4	1.6	0.0
Yellowstone Park	6,200	11	48	23.80	29.98	+.02	41.5												1.56	−0.9	5	4,460	sw.	56	w.	18	7	12	11	6.1	9.7	0.0
North Platte	2,821	11	51	26.99	29.92	.00	50.0	−1.4	60	22	45	9	16	26	35	29	28	66	1.92		14	5,077	nw.	54	w.	18	7	13	10	6.1	11.6	0.0
Middle Slope								+1.4	87	14	64	21	1	36	49	40	22	60	0.95	−0.4	9	6,501	nw.	33	nw.	24	7	11	12	6.1	5.6	0.0
							53.1	−0.3									30	58	0.20	−2.0	6	7,044	n.	30	s.	14	2	14	14	6.9	2.9	0.0
Denver	5,292	106	113	24.64	29.92	+.02	46.0	−1.1	76	23	58	18	26	34	42	36	25	53	1.60	−0.6	10	6,157	s.	40	n.	17	11	12	7	5.2	16.1	0.0
Pueblo	4,685	80	86	25.20	29.88	.00	48.4	−1.7	80	14	63	19	1	34	45	38	27	52	0.49	−0.9	6	5,523	nw.	42	nw.	17	11	14	5	4.6	T.	0.0
Concordia	1,392	50	58	28.42	29.89	−.04	54.6	+1.1	88	15	66	21	1	43	37	45	35	55	1.38	−1.0	6	5,733	s.	30	nw.	15	8	16	6	5.0	0.0	0.0
Dodge City	2,509	11	51	27.34	29.94	+.04	53.4	−0.2	86	15	66	27	1	41	38	44	37	64	2.34	+0.5	9	8,282	s.	35	sw.	15	16	6	8	4.0	T.	0.0
Wichita	1,358	139	158	28.47	29.90	−.03	56.2	−0.2	85	15	67	28	1	46	32	47	38	58	4.38	+1.7	7	10,326	s.	44	ne.	29	14	10	6	4.5	0.0	0.0
Broken Arrow	765	11	52	29.10	29.93		58.8		88	15	69	30	1	49	33				5.06		9	10,161	se.	64	nw.	29	13	7	10	5.0	0.0	0.0
Muskogee	652	4					61.4		92	15	74	27	1	49	38				7.25		9		se.				16	5	9		0.0	0.0
Oklahoma City	1,214	10	47	28.65	29.93	+.01	60.0	+0.2	90	15	70	34	1	49	35	50	43	61	3.67	+0.9	7	8,094	s.	48	n.	29	11	10	9	5.1	0.0	0.0
Southern Slope																																
							61.3	−1.3										52	1.36	−0.4										3.9		
Abilene	1,738	10	52	28.12	29.91	+.01	63.4	−1.0	91	21	76	33	1	51	37	52	43	56	2.92	+0.6	4	8,197	s.	46	sw.	24	15	4	11	4.6	0.0	0.0
Amarillo	3,676	10	49	26.19	29.90	+.03	55.1	+0.5	85	23	69	29	17	41	41	45	38	61	0.87	−0.8	7	8,066	s.	34	s.	15	17	12	1	3.4	T.	0.0
Del Rio	944	64	71	28.94	29.92	+.03	69.6	−1.0	95	21	81	41	1	58	36				1.11	−0.8	6	6,942	se.	48	n.	9	16	5	9	4.5	0.0	0.0
Roswell	3,566	75	85	26.27	26.85	.00	57.0	−3.6	85	20	72	27	1	42	50	43	25	38	0.53	−0.4	3	6,642	s.	42	nw.	3	18	8	4	3.2	T.	0.0
Southern Plateau																																
							56.1	−1.3										42	0.39	0.0										2.6		
El Paso	3,762	110	133	26.12	29.85	+.02	61.4	−2.4	84	28	74	35	17	49	40	44	25	33	0.32	+0.1	4	8,197	w.	52	w.	15	17	10	3	3.0	0.0	0.0
Santa Fe	7,013	38	53	23.16	29.84	.00	45.6	−1.1	69	23	58	19	17	34	33	35	23	48	1.26	+0.4	6	5,365	se.	36	w.	15	17	8	5	3.7	7.1	0.0
Flagstaff	6,907	10	59	23.27	29.85	+.01	41.2	−1.0	66	29	55	16	17	28	40	33		60	1.80		7		w.	41	s.	23	16	7	7		1.5	0.0
Phoenix	1,108	11	81	28.72	29.87	.00	65.0	−2.0	91	19	80	38	17	50	45	50	36	42	0.22	−0.2	2	4,115	w.	30	nw.	11	19	10	1	2.7	0.0	0.0
Yuma	141	9	54	29.73	29.88	−.01	67.1	−2.4	95	19	82	43	17	52	44	52	36	39	0.11	0.0	1	4,468	s.	32	ne.	11	24	6	0	1.5	0.0	0.0
Independence	3,957	5	25	25.93	29.95	+.05	56.3	+1.2	84	30	71	30	16	42	41	42	22	31	0.03	−0.1	1	8,813	nw.	46	w.	14	23	3	4	1.9	0.0	0.0
Middle Plateau																																
							48.5	+0.1										47	0.54	−0.5										3.4		
Reno	4,532	74	81	25.46	29.99	+.02	49.0	+1.7	76	21	64	21	16	34	39	37	24	44	0.18	−0.3	2	5,491	w.	38	w.	13	21	5	4	2.5	1.0	0.0
Tonopah	6,090	12	20	24.00	29.90		47.0		7	30	58	21	16	36	31	36	21	42	0.15		2		nw.									
Winnemucca	4,344	18	56	25.61	30.01	+.05	46.8	+0.1	76	30	64	12	16	30	49	36	22	45	0.23	−0.6	3	5,631	ne.	35	nw.	14	20	4	6	3.4	T.	0.0
Modena	5,479	10	43	24.56	29.90	+.02	45.8	−0.2	73	21	61	19	16	31	42	37	28	56	0.53	−0.3	3	8,484	w.	58	sw.	14	18	8	4	3.0	3.0	0.0
Salt Lake City	4,360	163	203	25.56	29.93	+.01	49.6	0.0	76	22	59	28	15	40	34	39	27	45	0.91	−1.4	4	6,347	nw.	34	s.	23	18	5	7	4.0	7.2	0.0
Grand Junction	4,602	60	68	25.29	29.86	−.02	51.2	−1.2	76	22	64	24	1	38	40	39	26	45	0.87	+0.1	4	4,989	se.	33	sw.	15	14	9	7	4.2	3.5	0.0
Northern Plateau																																
							48.8	−0.2										49	0.36	−1.0										5.2		
Baker	3,471	48	53	26.47	30.08	+.08	44.3	+0.9	73	21	58	20	15	31	42	36	26	54	0.54	−0.4	4	4,711	se.	26	n.	23	14	8	8	4.2	T.	0.0
Boise	2,739	78	86	27.17	30.04	+.06	49.8	−0.6	75	29	62	24	16	37	38	40	27	45	0.54	−0.6	5	4,701	nw.	26	nw.	24	15	9	6	4.2	T.	0.0
Lewiston	757	40	48	29.26	30.08	+.09	52.1	−0.8	78	29	65	28	15	39	45				0.23	−0.9	3	3,411	e.	30	w.	18	6	11	13	6.3	0.0	0.0
Pocatello	4,477	60	68	25.41	29.94	.00	46.5	+0.5	73	22	58	20	16	35	36	37	25	49	0.61	−1.4	8	6,831	sw.	36	sw.	14	8	11	11	5.7	1.5	0.0
Spokane	1,929	101	110	27.98	30.05	+.06	47.6	−0.8	74	27	59	27	15	36	40	38	26	48	0.11	−1.2	2	5,902	sw.	36	n.	16	6	11	13	5.9	T.	0.0
Walla Walla	991	57	65	28.99	30.07	+.06	52.8	−0.3	79	29	64	31	24	42	35	43	32	47	0.13	−1.6	4	4,618	sw.	30	sw.	18	12	11	7	4.6	T.	0.0
North Pacific Coast Region																																
							49.6	+0.5										72	1.49	−1.7										5.9		
North Head	211	11	56	29.95	30.19	+.14	47.6	+0.1	76	26	52	37	14	44	26	44	41	62	1.48	−1.8	14	12,345	nw.	46	nw.	22	2	5	23	8.1	0.0	0.0
Port Angeles	29	8	53		30.16		45.5		68	26	53	32	24	38	29				0.93	−1.0	9	5,758	s.	32	w.	16	9	12	9		T.	0.0
Seattle	125	215	250	30.04	30.17	+.14	49.0	−0.4	74	26	56	33	14	42	28	43	37	68	1.13	−1.2	8	6,573	s.	36	s.	17	7	8	15	6.4	1.5	0.0
Tacoma	213	113	120	29.94	30.15	+.12	48.8	+0.1	76	26	57	32	15	40	35				0.66	−2.2	8	6,781	sw.	39	sw.	16	4	14	12	6.8	0.0	0.0
Tatoosh Island	86	9	57	30.05	30.15	+.15	46.0	−0.1	65	25	50	37	3	42	21	45	44	92	4.91	−1.4	18	11,100	w.	46	e.	25	6	10	14	6.4	0.0	0.0
Yakima	1,071	4					53.5		83	6	70	28	4	37	48	45	37	62	0.38		3		nw.				12	3	15	3.8	0.0	0.0
Medford	1,425	5					53.0	+1.2	89	27	63	32	15	43	34	47	40	66	0.91	−2.1	9	4,697	nw.	25	e.	25	10	5	15	6.1	0.1	0.0
Portland, Oreg.	153	68	106	30.00	30.16	+.10	53.3	+2.3	84	2	68	32	24	39	47	45	37	63	0.45	−2.0	6	2,471	n.	20	sw.	14	12	14	4	4.0	0.0	0.0
Roseburg	510	9	57	29.60	30.16	+.09																										
Middle Pacific Coast Region							56.9	+2.0										64	0.39	−1.8										3.3		
Eureka	62	73	89	30.06	30.13	+.02	49.7	−0.2	67	29	56	37	4	44	21	46	44	82	0.67	−3.3	6	5,557	n.	32	n.	23	12	11	7	4.6	0.0	0.0
Point Reyes	490	7	18	29.48	30.00		51.8	+1.2	77	6	56	44	4	47	24				0.12		2	14,636	nw.	72	nw.	14	13	6	11	4.8	0.0	0.0
Red Bluff	332	50	56	29.63	29.99	−.04	63.6	+4.6	94	6	78	37	15	50	38	50	35	42	0.32	−1.5	1	5,149	nw.	31	n.	4	24	6	0	1.5	0.0	0.0
Sacramento	69	106	117	29.91	29.98	−.03	60.6	+2.5	88	6	74	41	4	47	38	51	44	61	0.30	−1.7	2	6,657	s.	36	nw.	4	24	4	2	1.8	0.0	0.0
San Francisco	155	208	243	29.85	30.02	−.03	57.4	+2.4	86	6	65	47	15	50	29	50	44	69	0.30	−1.5	2	7,418	w.	35	w.	14	17	6	7	3.8	0.0	0.0
San Jose	141	12	110	29.87	30.02		58.4	+1.7	90	6	71	36	16	45	41				0.30	−1.0	4	5,337	nw.	29	nw.	14	18	6	6	3.5	0.0	0.0
South Pacific Coast Region							59.6	+1.1										66	0.77	−0.3										4.2		
Fresno	327	89	98	29.62	29.98	−.01	62.0	+1.8	89	20	75	39	16	49	34	51	41	55	0.54	−0.2	3	5,044	nw.	36	nw.	15	22	5	3	2.3	0.0	0.0
Los Angeles	338	159	191	29.62	29.99	.00	60.4	+1.0	88	19	68	47	2	53	33	52	45	65	1.43	+0.3	6	4,288	sw.	28	n.	15	11	9	10	4.8	0.0	0.0
San Diego	87	62	70	29.89	29.98	−.01	59.4	+0.9	80	18	65	48	16	54	27	53	49	75	0.77	0.0	10	4,935	w.	28	w.	2	8	11	11	5.6	0.0	0.0
San Luis Obispo	201	32	40	29.81	30.03	−.02	56.6	+0.8	88	19	67	37	16	46	41	49	43	68	0.33	−1.2	5	3,332	nw.	20	w.	14	14	9	7	4.2	0.0	0.0
West Indies																																
San Juan, P. R	82	8	54	29.89	29.97		77.3	+0.7	90	15	83	68	26	72	18				6.77	+2.9	16	7,719	e.	31	e.	11	11	16	3	4.3	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.71	29.84	−.01	81.8	+0.2	95	19	90	72	16	74	21	75	73	83	3.72	+0.9	9	6,749	nw.	29	n.	8	0	22	8	6.2	0.0	0.0
Colon	36	7	97	29.82	29.86	.00	81.2	+0.2	89	17	86	74	20	76	14	75	74	81	10.85	+6.5	18	9,850	n.	29	n.	9	3	12	15	7.0	0.0	0.0
Alaska																																
Juneau	80	11	49	29.77	29.86		38.0		67	27	43	28	22	33	28	35	32	81	8.87		26	5,693	s.	37	se.	25	1	2	27	9.2	13.6	0.0

TABLE II.—*Data furnished by the Canadian Meteorological Service, April, 1924*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
St. Johns, N. F.	125												
Sydney, C. B. I.	48												
Halifax, N. S.	88												
Yarmouth, N. S.	65												
Charlottetown, P. E. I.	38												
Chatham, N. B.	28												
Father Point, Que.	20	29.94	29.96	+.03	31.6	−1.6	37.9	25.3	53	10	2.32	+0.74	17.2
Quebec, Que.	296	29.62	29.95	−.04	36.1	+1.0	41.9	30.4	60	12	4.58	+2.49	30.5
Montreal, Que.	187	29.71	29.92	−.08	41.0	+1.3	47.8	34.3	70	19	6.10	+3.86	17.1
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.68	29.96	−.06	41.6	+1.6	50.6	32.6	74	15	3.69	+2.19	10.0
Kingston, Ont.	285	29.63	29.95	−.07	41.4	+1.4	48.6	34.2	62	20	2.90	+1.11	4.1
Toronto, Ont.	379	29.55	29.97	−.05	42.8	+2.0	51.0	34.6	66	19	2.55	+0.18	3.5
Cochrane, Ont.	930												
White River, Ont.	1,244	28.58	29.93	−.11	31.6	−1.4	44.4	18.8	72	−10	0.92	−0.33	7.4
Port Stanley, Ont.	592												
Southampton, Ont.	656	29.24			38.7	0.0	46.5	30.9	40	5	0.85	−0.95	2.2
Parry Sound, Ont.	688	29.25	29.95	−.07	38.6	+1.0	48.0	29.3	62	3	2.42	+0.51	3.9
Port Arthur, Ont.	644	29.21	29.92	−.11	35.2	+1.7	41.7	28.8	51	9	1.52	−0.20	2.8
Winnipeg, Man.	760												
Minnedosa, Man.	1,690	28.06	29.91	−.10	32.6	−3.4	40.9	24.3	60	10	6.94	+5.88	58.9
Le Pas, Man.	860				27.9		38.6	17.3	58	−7	1.56		11.9
Qu'Appelle, Sask.	2,115	27.62	29.89	−.10	36.6	−0.8	46.5	26.8	65	12	1.15	+0.10	8.4
Medicine Hat, Alb.	2,144	27.57	29.84	−.08	44.6	+0.1	56.3	32.9	74	19	0.36	−0.38	3.4
Moose Jaw, Sask.	1,759				38.0		49.0	27.1	69	19	0.69		2.0
Swift Current, Sask.	2,392	27.32	29.97	+.01	38.3	−3.0	50.0	26.7	68	14	0.08	−0.85	0.8
Calgary, Alb.	3,428												
Banff, Alb.	4,521	25.29	29.90	.00	35.7	+0.4	46.4	25.1	66	5	1.17	+0.09	9.1
Edmonton, Alb.	2,150	27.59	29.90	+.01	37.5	−2.4	48.4	26.6	72	13	0.63	−0.25	6.3
Prince Albert, Sask.	1,450	28.37	29.98	.00	34.7	−1.4	46.0	23.4	69	6	0.82	−0.01	8.2
Battleford, Sask.	1,592	28.16	29.92	−.05	37.7	+0.5	49.9	25.6	74	12	0.15	−0.32	1.5
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.89	30.15	+.14	47.5	+0.7	53.8	41.2	70	34	1.83	−0.54	0.0
Barkerville, B. C.	4,180												
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170												

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Port Stanley, Ont.	592	29.25	29.91	−.12	30.2	+3.0	36.7	23.6	58	4	1.10	−1.78	7.7
Winnipeg, Man.	760	29.28	30.15	+.09	23.9	+11.6	33.0	14.8	46	2	0.09	−0.94	0.9
Medicine Hat, Alb.	2,144	27.62	29.92	−.08	31.5	+4.0	40.3	22.8	52	11	0.13	−0.63	1.3
Banff, Alb.	4,521	25.29	30.00	+.06	24.9	+4.7	37.9	12.0	47	−5	0.39	−1.02	3.9
Kamloops, B. C.	1,262	28.74	30.05	+.12	39.5	+3.4	49.9	29.2	58	15	0.14	−0.43	T.
Edmonton, Alb.	2,150	27.65	30.01	+.05	24.5	+0.3	33.4	15.7	45	−4	1.42	+0.70	14.2
Barkerville, B. C.	4,180	25.59	29.98	+.10	25.0	−1.1	34.2	15.8	41	−2	2.35	+0.46	23.5

SEISMOLOGICAL REPORTS FOR APRIL, 1924

W. J. HUMPHREYS, Professor in Charge

[Weather Bureau, Washington, June 3, 1924]

TABLE 1.—*Noninstrumental earthquake reports, April, 1924*

Day	Approximate time, Greenwich civil	Station	Approximate latitude	Approximate longitude	Intensity Rossi-Forel	Number of shocks	Duration	Sounds	Remarks	Observer
		CALIFORNIA								
1924	*H. m.*		° ′	° ′			*Sec.*			
Apr. 2	23 55	Spreckels	36 38	121 36	4 *ca.*	1	15	Rumbling	Felt by many	Spreckels Sugar Co.
3	23 50	Wrights	34 03	118 15	2	1	Brief.	Faint	do	C. E. Schmitt.
	23 52	Salinas	36 41	121 39	3	1	3 *ca.*	None	do	E. D. Eddy.
	23 54	San Francisco	37 48	122 26	3	3	2 *ca.*	do	do	W. Bailey.
	23 55	Los Gatos	37 12	121 58	5–6	1	7–8	Yes	do	I. H. Snyder.
		San Jose	37 15	121 53	5–6	3	1	Rumbling	Most severe since 1911	E. S. Nichols.
	23 56	Hayward	37 40	122 25	4	2	1–2	None	Felt by many	R. T. Robinson.
	23 57	Walnut Creek	37 55	122 15	5	1		do	do	G. D. Waener.
4	1 55	Yosemite	37 45	119 30	2	1	Few.	do	Felt by several	E. P. Leavitt.
11	6 12	Hayward	37 40	122 25	2	1	1	do	do	R. T. Robinson.
22	10 09	San Jose	37 15	121 53	3			Rattling	do	E. H. Jones.
		MONTANA								
9	3 52	Kalispell	48 15	114 30	3	1	1	Rumbling	Felt by many	J. Grover.
		WASHINGTON								
25	20 02	Seattle	47 38	122 20	3	1	5	None	do	M. B. Summers.

TABLE 2.—*Instrumental seismological reports, April, 1924*

Time used: Mean Greenwich, midnight to midnight. Nomenclature: International

[For significance of symbols and description of stations, see REVIEW for January, 1924]

ALASKA. *U. S. C. & G. S. Magnetic Observatory, Sitka*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 13		e_E	14 51 15	9				
		e_N	14 51 13					Tremors are superimposed on the long waves.
		L_E	14 53 22	10				
		M_E	14 52 42	15	*200			Recorded on the magnetograph.
		M_N	14 53 38	10		*500		
		F	15 02 --					
14		O	16 20 07				10,000	
		P_E	16 33 31	4				
		$PR1_E$	16 37 03	13				
		S_E	16 43 32	10				
		SP_E	16 44 31					
		SP_N	16 44 26					
		$SR1_E$	16 49 25	16				
		eSR_N	16 50 36					
		e_E	16 57 51	28				
		L_E	17 02 06	34				
		M_E	17 05 39	25	*1,700			
		M_N	16 58 17	25		*1,500		
		C_E	17 10 --					
		F	18 37 --					
21		e_E	20 23 56					Wind tremors troublesome.
		e_N	20 20 00	5				
		L_E	20 26 57	12				
		L_N	20 27 00	14				
		M_E	20 27 07	14	*400			
		M_N	20 27 00	14		*400		
		F	20 40 --					

* Trace amplitude.

ARIZONA. *U. S. C. & G. S. Magnetic Observatory, Tucson*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 14		O	16 20 15				12,100	
		$PR2_E$	16 42 17					Origin based on PR_2 and SR_2.
		e_E	16 45 45					Instrument not operating satisfactorily.
		PS_E	16 49 40					
		$SR1_E$	16 55 15					
		$SR2_E$	16 59 42					
		e_E	17 10 57	36				
		L_E	17 19 06					
		M_E	17 14 38	25	*400			
		F_E	18 19 --					
21		O	20 01 29				1,720	Recorded on the magnetograph.
		P_E	20 05 13	4				Observed in magnetometer observations.
		P_N	20 05 09					
		S_E	20 08 07					
		L_E	20 09 44	11				
		L_N	20 09 20					
		M_E	20 10 29	13	*6,100			
		M_N	20 10 10			*6,500		
		C_E	20 11 --					
		F_E	20 28 --					
		F_N	20 16 --					

* Trace amplitude.

CALIFORNIA. *Theosophical University, Point Loma*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 16			15 00 00		100	100		Tremors during preceding 24 hours.
19					50	50		
20					50	50		
21					100	100		
24					150	250		
28					50	50		

COLORADO. *Regis College, Denver*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 21		P	19 05 --					Mexico; good record; S indistinct.
		S	19 08? --					
		L_E	19 11 30	4.6				
		L_N	19 11 --	5				
		M_E	19 15 30	5	*7500			
		M_N	19 13 30	6		*8000		
		C_E	19 16 --					
		C_N	19 18 --					
		F_E	19 22 --					
		F_N	19 23 --					

* Trace amplitude.

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DISTRICT OF COLUMBIA. *U. S. Weather Bureau, Washington*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 14		P	16 39 46					
		i	16 41 54					
		PR1	16 43 15					
		S?	16 48 50					
		eL	16 49 --	32				
		L	17 15 22	20				
		L	17 35 --	20				
		L	17 46 --	16				
		F	18 50 --					
21		P	20 06 35				3,200	
		S?	20 11 12					
		F	20 45 *ca*					

HAWAII. *U. S. C. & G. S. Magnetic Observatory, Honolulu*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 3		e_E	1 52 --					
		e_N	1 44 40					
		M_N	1 49 30	14		65		
		F	2 01 --					
14		e_E	9 14 --					
		e_N	9 16 48					
		F	9 23 --					
14		O	16 20 05				8,900	N component not operating.
		P_E	16 32 13					
		S_E	16 42 18					
		$SR2_E$	16 51 52					
		i_E	16 55 21	24	350			
		L_E	17 01 05	25				
		M_E	17 03 21	20	390			
		F_E	19 12 --					
21		O	20 01 19				5,700	
		P_E	20 10 32					
		S_E	20 17 52	10				
		S_N	20 17 55	7				
		L_E	20 25 20					
		L_N	20 24 00	14				
		M_E	20 18 35	10	13			
		M_N	20 18 49	7		14		
		F	20 45 --					
29		e_E	21 12 13					E obscured by overlapping traces.
		M_N	21 16 --	20		19		
		F_E	21 34 --					
30		e	4 26 --					
		F	4 34 --					
30		e	5 25 38					
		F	5 50 --					

ILLINOIS. *U. S. Weather Bureau, Chicago*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 12		eL	22 43 40					
		L	22 48 --	18				
		F	23 08 *ca.*					
13		e	15 09 00					Confused; heavy micros.
		F	15 25 *ca.*					
14		e	9 48 15					
		L	9 55 20	16				
		F	10 10 *ca.*					
14		P	16 41 30				8,200	
		PR1	16 46 58					
		S	16 51 06					
		L	16 58 44	36				
		L	17 20 --	25				
		L	17 50 --	18				
		F	20 *ca.* --					
21		P	20 06 38				2,800	
		S	20 11 02					
		L	20 13 45	30				
		F	21 32 *ca.*					
28		eL	21 48 --	18				
		F	23 *ca.* --					
29			9 40 *to* 10 20 --					Occasional sinusoidal waves; may not be seismic.

ILLINOIS. *U. S. Weather Bureau, Chicago*—Continued

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 29	.....	P.....	21 12 00	.....	.....	.....	.....	
		S?.....	21 18 00	.....	.....	.....	.....	
		L.....	21 27 ..	22	.....	.....	.....	
		L.....	21 33 ..	16	.....	.....	.....	
		F.....	22 35 *ca.*	.....	.....	.....	.....	
30	.....	P?.....	4 24 30	.....	.....	.....	.....	Probably two or more quakes; mostly sinusoidal, period 16 sec.
		S?.....	4 34 20	.....	.....	.....	.....	
		eL.....	4 40 25	16	.....	.....	.....	
		F.....	7 30 *ca.*	.....	.....	.....	.....	

MARYLAND. *U. S. C. & G. S. Magnetic Observatory, Cheltenham*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 14	.....	O.....	16 20 29	.....	.....	.....	14,300	
		P_E.....	16 40 12	3	.....	.....	.....	Origin based on L1 and $SR2_E$.
		P_N.....	16 39 54	3	.....	.....	.....	
		$PR1_E$.....	16 43 08	.....	.....	.....	.....	
		$PR2_N$.....	16 43 02	3	.....	.....	.....	
		$SR1_N$.....	16 59 25	.....	.....	.....	.....	
		$SR2_E$.....	17 04 31	30	.....	.....	.....	
		$SR2_N$.....	17 04 35	35	.....	.....	.....	
		e_N.....	17 17 21	.....	.....	.....	.....	
		L1.....	17 23 03	.....	.....	.....	.....	
		$L2_E$.....	17 28 28	23	.....	.....	.....	
		$L2_N$.....	17 27 40	32	.....	.....	.....	
		M_E.....	17 38 46	20	*200	.....	.....	
		M_N.....	17 28 44	28	.....	*600	.....	
		C_N.....	17 42 ..	22	.....	.....	.....	
		F_E.....	18 00 ..	16	.....	.....	.....	
		F_N.....	18 22 ..	16	.....	.....	.....	
21	.....	O.....	20 01 22	.....	.....	.....	3,060	No definite maxima.
		P_E.....	20 07 24	4	*100	.....	.....	
		P_N.....	20 07 40	3	.....	.....	.....	
		S_N.....	20 12 11	.....	.....	.....	.....	
		L_N.....	20 14 18	6	.....	*100	.....	
		F_E.....	20 30 ..	.....	.....	.....	.....	
		F_N.....	20 35 ..	.....	.....	.....	.....	

*Trace amplitude.

CANAL ZONE. *Panama Canal, Balboa Heights*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 2	.....	.....	.....	.....	.....	.....	.....	Very slight disturbance, 4:37:44 to 7:37:44.
14	.....	.....	.....	.....	.....	.....	.....	Slight tremors between 16:39:34 and 16:45:00.
14	.....	.....	.....	.....	.....	.....	.....	Slight tremors from distant disturbance between 16:49 and 18:20.
21	.....	.....	.....	.....	.....	.....	.....	Slight tremors between 20:05:54 and 20:21:00.

PORTO RICO. *U. S. C. & G. S. Magnetic Observatory, Vieques*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 13	.....	e_E.....	1 26 50	13	*200	.....	.....	Severe wind tremors prevailing.
		F_E.....	1 38 ..	.....	.....	.....	.....	
14	.....	O.....	16 20 23	.....	.....	.....	16,700	Origin based on L_{1E} and SR_{2E}.
		P_E.....	16 40 49	4	.....	.....	.....	
		P_N.....	16 40 37	3	.....	.....	.....	
		PS_E.....	16 54 46	12	.....	.....	.....	
		SR_{1E}.....	17 03 48	13	.....	.....	.....	
		SR_{1N}.....	17 05 39	.....	.....	.....	.....	
		SR_{2E}.....	17 09 19	.....	.....	.....	.....	
		e_E.....	17 24 04	28	.....	.....	.....	
		L_{1E}.....	17 33 47	33	.....	.....	.....	
		L_{2E}.....	17 39 09	22	.....	.....	.....	
		L_{1N}.....	17 35 35	.....	.....	.....	.....	
		L_{2N}.....	17 38 49	28	.....	.....	.....	
		M_E.....	17 43 26	23	*1,000	.....	.....	
		M_N.....	17 42 58	25	.....	*2,100	.....	
		C.....	18 00 ..	.....	.....	.....	.....	
		F_E.....	18 24 ..	.....	.....	.....	.....	
		F_N.....	18 16 ..	.....	.....	.....	.....	
18	.....	P.....	6 48 39	.....	.....	.....	.....	Felt by many in Vieques. Noise as of explosion or escaping steam, according to some reports.
		S_N(?)...	6 48 45	.....	.....	.....	.....	
		iL_N.....	6 48 47	0.5	.....	20	.....	
		M_E.....	6 48 47	0.5	20	.....	.....	
		F_E.....	6 49 02	.....	.....	.....	.....	
		F_N.....	6 49 08	.....	.....	.....	.....	
21	.....	O.....	20 01 20	.....	.....	.....	3,420	
		P_E.....	20 07 54	3	.....	.....	.....	
		P_N.....	20 08 09	4	.....	.....	.....	
		PR_E.....	20 08 51	8	.....	.....	.....	
		S_E.....	20 13 06	9	*200	.....	.....	
		S_N.....	20 13 06	5	.....	*200	.....	
		L_E.....	20 18 48	11	*100	.....	.....	
		L_N.....	20 18 10	5	.....	.....	.....	
		F_E.....	20 32 ..	.....	.....	.....	.....	
		F_N.....	20 21 ..	.....	.....	.....	.....	

* Trace amplitude.

PORTO RICO. *U. S. C. & G. S. Magnetic Observatory, Vieques*—Continued

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 22	.....	P_E.....	15 43 06	.....	.....	.....	.....	Felt by a few in Vieques.
		P_N.....	15 43 02	.....	.....	.....	.....	
		L_E.....	15 43 21	.....	.....	.....	.....	
		iL_N.....	15 43 18	.....	.....	.....	.....	
		M_E.....	15 43 22	0.5	50	.....	.....	
		M_N.....	15 43 19	0.5	.....	60	.....	
		F_E.....	15 44 39	2	.....	.....	.....	
		F_N.....	15 45 20	.....	.....	.....	.....	

VERMONT. *U. S. Weather Bureau, Northfield*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 14	.....	e.....	16 41 30	.....	.....	.....	.....	
		eL.....	16 58 ..	40	.....	.....	.....	
		L.....	17 26 ..	28	.....	.....	.....	
		L.....	17 42 ..	20	.....	.....	.....	
		L.....	17 50 ..	16	.....	.....	.....	
		F.....	18 30 *ca*	.....	.....	.....	.....	
21	.....	e.....	20 08 ..	.....	.....	.....	.....	
		F.....	20 40 *ca*	.....	.....	.....	.....	

CANADA. *Dominion Observatory, Ottawa*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 6	.....	e17.....	21 50 24	.....	.....	.....	.....	
		eL.....	21 56 ..	22	.....	.....	.....	Small. On No. 17 only.
		L.....	22 02 ..	18	5	.....	.....	
		L.....	22 20 ..	16	3	.....	.....	
		F.....	22 37 ..	.....	.....	.....	.....	
8	.....	eL17...	9 58 ..	15	.....	.....	.....	Do.
		F.....	10 05 ..	.....	.....	.....	.....	
10	.....	e?.....	20 15 38	.....	.....	.....	.....	On No. 17 only.
		e?.....	20 18 28	.....	.....	.....	.....	
		eL17...	20 28 ..	.....	.....	.....	.....	
		L.....	20 36 ..	15	.....	.....	.....	Small. True half-amplitude less than one micron.
		L.....	20 45 ..	15	.....	.....	.....	
		F.....	21 15 ..	.....	.....	.....	.....	
11	.....	eL17...	14 08 ..	.....	.....	.....	.....	
		L17.....	14 12 30	15	.....	.....	.....	Small.
		F.....	14 28 *ca*	.....	.....	.....	.....	
12	.....	eL17...	22 58 ..	.....	.....	.....	.....	May not be seismic.
		F.....	23 03 ..	.....	.....	.....	.....	
13	.....	eL17...	14 27 ..	.....	.....	.....	.....	
		L17.....	14 48 ..	.....	.....	.....	.....	
		i.....	15 10 00	.....	.....	.....	.....	May be another quake.
		i.....	15 10 40	.....	.....	.....	.....	
		L_{NE}.....	15 11 16	.....	.....	.....	.....	
		L17.....	15 12 45	12	5	.....	.....	
		L.....	15 38 ..	.....	.....	.....	.....	
		F.....	15 51 ..	.....	.....	.....	.....	
14	.....	eL17...	9 53 30	.....	.....	.....	.....	
		L17.....	10 05 ..	15	.....	.....	.....	Small.
		L17.....	10 17 30	.....	.....	.....	.....	
		F.....	10 46 ..	.....	.....	.....	.....	
14	.....	*O*.....	(16 25 33)	.....	.....	.....	(11180)	Difficult to read; P may be earlier; extra phases perhaps due to two quakes.
		ePv....	(16 39 31)	.....	.....	.....	.....	
		1i.....	16 41 25	.....	.....	.....	.....	
		2i.....	16 42 36	.....	.....	.....	.....	
		PR1...	16 43 49	.....	.....	.....	.....	
		i.....	16 46 41	.....	.....	.....	.....	
		e.....	(16 48 30)	.....	.....	.....	.....	
		e.....	16 58 30	.....	.....	.....	.....	
		S.....	16 51 19	.....	.....	.....	.....	
		eL.....	17 15 ..	.....	.....	.....	.....	
		M1.....	17 16 ..	60	350	.....	.....	
		L.....	17 24 ..	26	180	.....	.....	
		M2.....	17 27 ..	26	360	.....	.....	
		M3.....	17 32 ..	26	260	.....	.....	
		L.....	17 40 ..	19	130	.....	.....	
		L.....	18 01 ..	16	44	.....	.....	
		LR1...	18 31 ..	15	17	.....	.....	
		F.....	21 *ca.*	.....	.....	.....	.....	
			HALIFAX RECORD					
		1i.....	16 41 48	.....	.....	.....	.....	
		2i.....	16 43 04	.....	.....	.....	.....	
		i.....	(16 46 51)	.....	.....	.....	.....	
		e.....	16 48 42	.....	.....	.....	.....	
		e.....	16 59 18	.....	.....	.....	.....	
		eL.....	17 20 ..	.....	.....	.....	.....	
15	.....	e.....	12 12 ..	.....	.....	.....	.....	
		eL17...	12 15 30	.....	.....	.....	.....	
		L17.....	12 20 ..	15	.....	.....	.....	Small.
		F.....	12 40 ..	.....	.....	.....	.....	
15	.....	eL17...	22 00 ..	.....	.....	.....	.....	
		L17.....	22 09 ..	15	.....	.....	.....	Small.
		F.....	22 35 ..	.....	.....	.....	.....	
17	.....	eL17...	21 56 40	16	.....	.....	.....	Small.
		F.....	22 13 ..	.....	.....	.....	.....	

CANADA. *Dominion Observatory, Ottawa*—Continued

			H. m. s.	Sec.	μ	μ	Km.	
Apr 18		eL17	12 04 30					
		L17	12 09 *to*					
		L17	12 15 --	15				Small.
		F	12 25 --					
20		e17	14 55 26					
		e17	15 00 19					
		eL17	15 15 --	30				Small.
		L17	15 36 30	18	5			
		L17	15 40 --	15				Small. Micros.
		F						
21		*O*	20 01 09				3440	
		eP	20 07 45					
		PR2	20 08 53					
		i	20 09 16					
		S	20 12 58					
		SR2	20 14 40					
		eL	20 16 40					
		M17	20 20 --	30	73			
		L17	20 24 --	20	29			
		L17	20 33 --	10	5			
		F	21 40 --					
25		eLe	18 47 --					Irregular L waves; very small amp.
		Le	18 52 36					
		Le	19 05 --	(19)				
		Le	19 22 --	(15)				
		F	19 40 --					
28		e17	17 46 30					
		e17	17 51 45					
		F	18 07 *ca.*					
28		e?	21 22 25					
		e	21 25 45					
		S?	21 31 53					
		L	21 53 00					
		L	21 57 --	20	6			
		L	22 03 --	17	7			
		L	22 12 --	16	4			
		F	23 30 *ca.*					
29		e	9 29 24					
		eL17	9 32 36					
		L17	9 42 --	15				Small.
		F	9 52 --					
29		e	10 05 32					
		eL	10 09 18					
		L	10 11 30	13				Small.
		F	11 05 *ca.*					
29		*O*	(21 04 14)				(5440)	
		P?	21 13 10					
		e	21 16 38					
		S?	21 20 16					
		eL	21 27					
		L	21 30 --	16	4			Sinusoidal.
		L	21 43 --	15				Small.
		F	22 30 *ca.*					
30		*O*	(4 12 13)				(10300)	Remarkably long-continued sinusoidal L waves of small and constant amplitude.
		eP	4 25 30					
		PR1	4 29 30					
		eS	4 36 41					
		SR2	4 53 32					
		eL	5 03 --					
		L	5 12 --	18	5			
		L	5 34 --	15	3.5			
		L or S	5 45 --					May be second quake.
		L	6 17 --	17	4			
		L	6 25 --	17	6.5			
		F	7 35 --					
30		eL	10 18 --					
		L	10 25 30					
		L	10 31 --					
		F	10 50 --					

CANADA. *Meteorological Service of Canada, Toronto*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 3		e?	{23 57 32				4,660	Preliminaries not well defined. Very small amp.
			{-- -- 38					
		eP	23 59 08					
		eS	0 05 32					
W		L	0 10 15					
		L	0 11 15					
		F	0 22 --					
		e	23 59 28					
		eS	0 05 23					
N		eL	0 11 15					Sinusoidal waves.
		L	0 11 34					
			to					
			0 12 38	15	4			
		F	0 23 00					
4		L	0 57 00					Small, may not be seismic.
W		F	1 02 --					
		e	0 57 27					
N		F	0 59 --					

CANADA. *Meteorological Service of Canada, Toronto*—Continued

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 6		e	21 49 30					
		eL	21 56 53					Sinusoidal.
		L	22 13 --	19 to 15		6		N-S component not effected.
		F	?					
8		e?	9 56 10					
		L	9 59 23					
W		L	10 01 08					Micros mask early phases. Sinusoidal.
		L	10 02 21					
			to					
			10 03 15	15		4		
		F	10 10 --					
		e	10 01 15					
N		L	10 02 15	15	2			
		F	-- -- --					Micros.
11		L	14 12 38					Boom disturbed by high wind. N-S component not effected.
W		F	?					
12		L	{10 41 20					P. & S. masked by micros.
W		L	{10 44 38					
			to					Remarkable for the long continuous and uniform sinusoidal waves of long period.
		L	11 24 38	30		13		
		F	11 27 --					
		e?	10 02 30					
		L	{10 46 38					Sinusoidal.
N		L	{10 51 21					
			{11 16 10					
			to					
			11 19 00	30	9			
		F	11 29 --					
13		e	14 27 30					
		i	15 10 36	8				
W		eL	15 16 30	15		5		
		eL	15 16 47					
		L	15 36 15					
		F						Micros.
		e	?14 27 30					
		i	{15 10 39					Small uniform waves.
N			{15 12 43					
			{15 13 32	10	4			
		L	15 13 52	10				Micros.
14		L	9 56 23					N-S component, barely effected.
		L	10 01 08	15				
W		L	10 02 --			2		
		F	10 46 00					
14		P	16 39 29				11,110	
		i	16 41 28	17				P doubtful owing to micros and wind.
		i	16 46 38	10				
		S	16 51 14	11				
		iL	16 59 12	38		538		
W		L	17 15 52	50				Possibly a dual quake.
		i	17 20 23	30		390		
		M1	17 26 30	28		384		
		M2	17 26 58	28		376		Large vibs. continued to 18h 16m.
		M3	17 27 23	28		360		
		F	Micros.					
		i	16 41 24					Possibly a dual eq
		i	16 46 38	8				
		S	16 51 15	10				Difficult to interpret.
N		i	16 58 57					
		i	16 59 15	25	243			Preceded by double swing.
		i	16 59 30		273			
		L	17 15 58					
		M1	17 26 15	30	442			
		M2	17 26 41	30	475			
		L	18 01 15	15				
		F	21 05 --					
15		L	12 14 15					N-S component, not effected.
W		L	12 22 38					Slow waves, small amp.
15		L	22 20 26					Slow waves, small amp.
		L	22 28 23					
W		F	22 30 --					
		L	22 18 38					
N		F	22 30 --					Very small.
18		L	12 09 38					N-S component, not effected.
		F	12 24 00					Very small.
20		L	15 12 23					N-S component, barely effected.
		L	15 30 23	30				
		L	15 34 53			3		
		F	Micros.					
21		O	20 00 59					P poorly defined.
		P	20 07 12					
		iS	20 12 08	8			3,180	
W		L	20 16 23					Mexico City rocked
		M	20 24 23	13		22		
		F	21 48 00					

CANADA. *Meteorological Service of Canada, Toronto*—Continued.

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 21		P	20 07 08					
		iS	20 12 04					
		iSR	20 12 52	10				P not well defined.
		iL	20 17 08					
N		iL	20 17 23					
		M	{20 18 08 / 20 18 24}		63?			
		M	20 22 10				3,180	
		M	20 24 30		25			
		F	?21 56 ..					
24		L	5 04 45					N–S component,
		L	5 15 30					nothing.
W		L	5 24 38					Slow waves may
		F	5 35 00					not be seismic.
25		L	18 46 45					Irregular waves,
		L	18 56 23					small amp.
W		L	19 00 45					
		F	19 54 ..					
		e	18 54 23					
N		L	18 55 23					Irregular waves.
		F	19 24 ..					
28		L	17 52 15					E/W component,
			17 54 52	23				barely effected.
N								Sinusoidal.
		L	17 56 to	23	8			
			17 59 ..					
		F	18 02 ..					
28		e	21 22 23					
		e	21 23 15					
		e	21 26 23					
W		e	21 31 26					
		L	21 54 15					Sinusoidal.
		L	21 56 30					
			22 11 30	15		5		
		F	?23 16					
		e	21 22 23					Very slight mark-
								ing.
		e	21 31 52					Very slight mark-
N		L	21 54 15					ing.
		L	21 54 53	23				Sinusoidal.
			21 59		5			
		F	23 16					
29		L	9 34 23					
		L	9 35 30	15				Sinusoidal.
			9 36 45	15		2		
W			to					May be a dual eq.
			9 37 52					
		e	9 43 30					
		L	9 44 15					Sinusoidal.
			9 45 30	15		3		
		F	9 48					
		e	9 30 05					
		L	9 35 11					Sinusoidal
N			9 44 15					
		L	9 45 11	15	3			
		F	9 52					
29		O	21 02 15					
		eP	21 12 15					
W		eS	21 20 18					
		eL	21 27 09					Sinusoidal.
			21 28 10	18			6,500	
				to				
		L	21 41 38	22		11		
		F	22 38					
		eP	21 12 15					
		eS	21 20 15					
N		eL	21 28 40	19			6,440	
				23	9			Sinusoidal off and
		L	21 53 45	15				on.
		F	22 29					
30		e	4 25 15					
		e	4 29 30					
		e	4 36 13					
		eL	5 03 15	15		4		
W			5 07 to					Long continued
			6 54 45	15		4		sinusoidal L
								waves.
		F	7 40					May be 2 or 3
								quakes.
		e	4 27 35					
		eS	4 36 10					
N		eL	4 52 45					Sinusoidal.
		L	4 53 08	15	4			
			6 41 00					
		F	7 40 00					
30		e	10 16 15					
		eL	10 24 23					N–S component,
W		L	10 24 45	15		2		barely effected.
		F	10 47					

CANADA. *Meteorological Service of Canada, Victoria.*

1924	*H.m.s.*		*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Apr. 3		L	2 09 03	20				N–S component,
E		M	2 10 23	15		2		too small to
		F	?2 12 03					measure.
4		L	0 00 25	20				
E		M	0 02 15	10		3		
		F	0 05 50					
		L	0 01 05	15				
N		M	0 02 08	8	2			
		F	0 04 15					
6		L	21 35 12	20				N–S component,
		M	21 42 17	20		9		too small to
E		F	22 03 12					measure.
8		O	10 09 10					
		P	10 10 36	5				
		L	10 11 46	12				
E		M	10 12 26	15		4	640	
		F	10 21 01					
		O	10 08 55					
		P	10 10 26	5				
		L	10 11 41	10				
N		M	10 14 21	12	3		680	
		F	10 19 31					
9		O	?22 36 42					N–S component,
		P	22 39 34	5				too small to
		L	22 41 52	12				measure.
E		M	22 42 34	18		3	1,320	
		F	22 46 34					
12		L	?22 31 02	20				N–S component,
E		M	22 35 00	20		4		too small to
		F	22 44 47					measure.
13		O	14 14 24					N–S too small to
		P	14 16 33	10			8,930	measure.
		S	14 26 40	15				
E		L	?14 39 43	20				
		M	14 40 56	20		6		
13		O	14 55 12					
		P	14 56 13	5				
E		L	14 57 03	18				
		M	14 58 47	12		9	450	
		F	?15 16 33					
		O	?14 56 25					
		P	14 57 18	5				
		L	14 58 00	15				
N		M	14 59 46	15	7		380	
		F	15 09 38					
14		P	9 19 19	8				
		L	9 38 49	20				
E		M	9 41 09	20		5		
		F	9 55 19					
		P	9 19 19	8				
		L	9 37 19	20				
N		M	9 40 12	20	4			
		F	9 49 14					
14		O	16 21 37					
		P	16 34 17	6				
		S	16 44 55	12				Off Philippine Is-
E		L	17 01 17	25				lands; max. rec-
		M	17 07 00	28		821	9,560	ord here.
		F	20 32 15					
		O	16 21 37					
		P	16 34 17	8				
		S	16 44 55	14				
N		L	17 01 17	25				
		M	17 02 35	28	304		9,560	
		F	20 13 15					
17		L	21 48 36	15				N–S component,
E		M	21 51 36	12		1		too small to
								measure.
18		P	10 27 18	5				
		L	10 28 48	12				
E		M	10 29 47	12		3	830?	
		F	10 38 08					
		P	10 27 38	5				
		L	10 29 03	12				
N		M	10 29 53	10	3		780?	
		F	10 38 08					
20		L	15 30 52	25				
E		M	15 33 42	22		7		
		F	15 51 17					
		P	14 56 52	8				
		L	15 25 52	30				
N		M	15 39 07	20	5			
		F	15 56 17					
21		O	20 02 50					
		P	20 08 06	5				
		S	20 12 18	10				

CANADA. *Meteorological Service of Canada, Victoria*—Continued.

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 21		L	20 19 18	22				
E		M	20 20 48	20		134	2,590	Mexico.
		F	21 11 13					
		O	20 02 39					
		P	20 08 01	8				
		S	20 12 18	10				
N		L	20 19 28	25				
		M	20 20 18	20	140		2,650	Mexico.
		F	21 18 58					
25		P	18 25 46	8				
		L	18 38 46	12				
E		M	18 40 36	10		2		
		F	19 26 06					
		P	18 25 46	8				
		L	18 38 58	12				
N		M	18 40 41	10	3			
		F	19 16 16					
28		M	2 15 17	14		2		N-S component, too small to measure.
E								
28		L	21 36 31	20				
E		M	21 51 49	20		6		
		F	22 09 31					
		L	21 41 21	18				
N		M	21 49 36	15	3			
		F	22 10 01					
29		P	9 46 24	5				
		L	?					
E		M	9 54 39	10		2		
		F	10 29 04					
		P	?9 46 59	10				
		L	?					
N		M	9 56 04	12	4			
		F	?10 26 44					
29		L	21 07 04	18				
E		M	21 20 44	18		7		
		F	21 56 24					
		L	21 07 04	20				
N		M	21 20 50	12	3			
		F	21 40 49					
30		P	4 24 06	8				
		L	4 45 36	15				
E		M	4 57 26	15		4		
		F	5 17 06					
N		P	4 24 10	8				
		L&M	?					
30		P	5 32 36	8				
		L	5 52 56	15				
E		M	6 01 44	15		4		
		F	6 33 06					
		P	5 32 34	10				
N		L	5 53 16	15				
		M	5 57 06	20	6			
		F	6 29 06					

Reports for April, 1924, have not yet been received from the following stations:

DISTRICT OF COLUMBIA. *Georgetown University*, Washington.
MASSACHUSETTS. *Harvard University*, Cambridge.
MISSOURI. *St. Louis University*, St. Louis.
NEW YORK. *Cornell University*, Ithaca; *Fordham University*, New York.

TABLE 3.—*Late reports (instrumental)*

DISTRICT OF COLUMBIA. *Georgetown University, Washington*

1924			H. m. s.	Sec.	μ	μ	Km.	
Feb. 18		e_E	7 23 21					Very heavy micros; no other phases.
		e_N	7 22 59					
24		eL	6 06 00					
		L	6 09 00					
		F	6 20					

CANADA. *Meteorological Service of Canada, Victoria*

1924			H. m. s.	Sec.	μ	μ	Km.	
Mar. 4		O	10 07 01					
		P	10 16 46	6				
		S	10 24 35	10				
E		L	10 34 00	32				
		M	10 42 25	22		116	6,240	Costa Rica.
		O	10 07 26					
		P	10 16 50	6				

CANADA. *Meteorological Service of Canada, Victoria*—Continued.

1924			H. m. s.	Sec.	μ	μ	Km.	
Mar. 4		S	10 24 20	10				
N		L	10 23 33	35				
		M	10 36 45	26	222		5,880	Costa Rica.
		F						Merged into next quake.
4		L	12 10 40	30				
E		M	12 14 40	20		23		
		F	13 16 00					
		L	12 08 25	22				
N		M	12 12 45	30	50			
		F	13 22 00					
5		P	4 49 29	8				
		S	74 58 32	12				
E		L	5 16 21	20				
		M	?			1	7,670?	
		F	?					
		S	4 59 25	10				
		L	5 09 01	20	1			
N		M	?					
		F	?					
10		O	8 32 31					
		P	8 34 11	3				
E		L	8 35 33	10				
		M	8 36 03	8		6	750	
		F	8 42 11					
		O	8 32 31					
		P	8 34 11	3				
		L	8 35 33	10				
N		M	8 35 51	9	6		750	
		F	8 42 11					
11		L	11 11 04	20				
		M	11 16 04	18		26		
E		F	12 05 02					
		L	11 10 02	25				
N		M	11 14 02	20	20			
		F	12 04 32					
11		M	21 08 32	20		4		
E		F	?					
		M	21 09 47	15	4			
N		F	?					
11		L	23 15 34	30				
E		M	23 17 00	18		5		
		F	?23 30 02					
		L	23 14 17	35				
N		M	23 17 00	16	5			
		F	23 30 02					
12		M_E	3 27 33	18		5		
		M_N	3 27 33	18	5			
12		L	14 22 40	10				
E		M	14 25 25	20		9		
		F	?					
		P	14 10 03	6				
N		L	14 22 43	30				
		M	14 25 07	20	12			
		F	14 32 05					
13		M_E	10 57 56	30		12		N-S component, not visible.
14		P	2 38 19	8				
		L	?2 46 07	22				
E		M	2 47 02	22		7		
		F	2 55 07					
		P	2 38 27	6				
		L	2 46 07	22				
N		M	2 47 11	22	4			
		F	2 56 07					
15		O	10 31 01					
		P	10 41 11	5				
		S	10 49 23	8				
E		L	11 00 26	28				
		M	11 01 21	28		65	6,680	Kurile Islands.
		F	12 28 11					
		O	10 31 10					
		P	10 41 11	8				
N		S	10 49 15	10				
		L	11 00 16	30				
		M	11 08 31	12	20		6,520	Do.
		F	12 28 11					
16		P	1 41 51	8				
		L	1 56 16	12				
E		M	2 01 33	12		2		
		F	?2 06 11					
		P	1 41 49	8				
		L	1 56 11	12				
N		M	?		1			
		F	2 06 11					
16		L	11 06 37	12				E-W component, too small to measure.
N		M	11 08 26	12	2			
		F	11 12 12					

CANADA. *Meteorological Service of Canada, Victoria*—Continued.

1924			*H., m. s.*	*Sec.*	μ	μ	*Km.*	
Mar. 17		L	23 09 59	10				N–S component.
E		M	23 10 54	10		2		too small to
		F	23 11 30					measure.
22		O	13 14 28					
		P	13 20 40	10				
		S	13 25 35	12				
E		L	13 35 40	22				
		M	13 38 25	18		11	3,170	
		F	13 53 40					
N		M	13 38 36	12	4			
		F	13 48 35					
24		L	12 14 36	12				N–S too small to
E		M	(?)			1		measure.
24		P	20 48 08	8				
		L	20 58 08	15				
E		M	21 06 38	18		12		
		F	21 46 33					
		P	20 48 06	8				
		L	20 58 08	25				
N		M	21 04 18	14	8			
		F	21 46 58					
25		O	14 12 24					
		P	14 19 58	6				
		S	14 25 58	10				
E		L	14 33 20	22				
		M	14 44 20	15		11	4,220	Prob. S. Mexico.
		F	(?)					
		S	14 25 58	12				
		L	14 31 58	30				
N		M	14 42 28	20	15			
		F						Merged in second quake. Prob. S. Mexico.
25		L	15 33 50	20				
E		M	15 36 40	18		12		
		F	16 01 00					
		O	15 08 47					
		P	15 16 28	8				
		S	715 22 33	10				
N		L	15 34 31	15				
		M	15 36 38	18	7		4,320	
		F	15 57 58					
26		P	20 25 40	8				
		L	20 39 29	25				

CANADA. *Meteorological Service of Canada, Victoria*—Continued.

1924			*H., m. s.*	*Sec.*	μ	μ	*Km.*	
Mar. 26		M	20 43 34	18		6		
E		F	21 34 44					
		P	20 25 04	8				
		L	20 39 49	20				
N		M	20 43 07	20	7			
		F	21 19 59					
27		P	8 52 38	5				
		L	9 00 10	10				
E		M	9 09 20	15		2		
		F	9 22 00					
		L	9 00 00	10				
N		M	9 06 35	10	1			
		F	9 22 00					
27		P	13 56 20	3				E-W component
		L	13 56 50	8				too small to
N		M	13 57 05	8	1			measure.
		F	14 00 10					
28		L	5 27 22	20				
E		M	5 29 46	15		2		
		F	5 43 00					
		L	5 27 38	20				
N		M	5 30 12	14	2			
		F	5 39 40					
30		O	0 08 15					
		P	0 10 12	8				
E		L	0 11 46	15				
		M	0 12 08	18		400	880	May be in Mon-
		F	2 05 04					tana.
		O	0 08 24					
		P	0 10 12	8				
N		L	0 11 40	10				
		M	0 12 08	12	230		810	Do.
		F	1 54 04					
30		O	12 10 16					
		P	12 11 17	8				
		L	12 12 07	12				
E		M	12 12 55	10		10	450	
		F	12 21 05					
		O	12 10 16					
		P	12 11 17	8				
		L	12 12 07	12				
N		M	12 13 05	10	10		450	
		F	12 20 05					

(Plotted by Wilfred F. Day.)

(Plotted by Wilfred P. Day.)

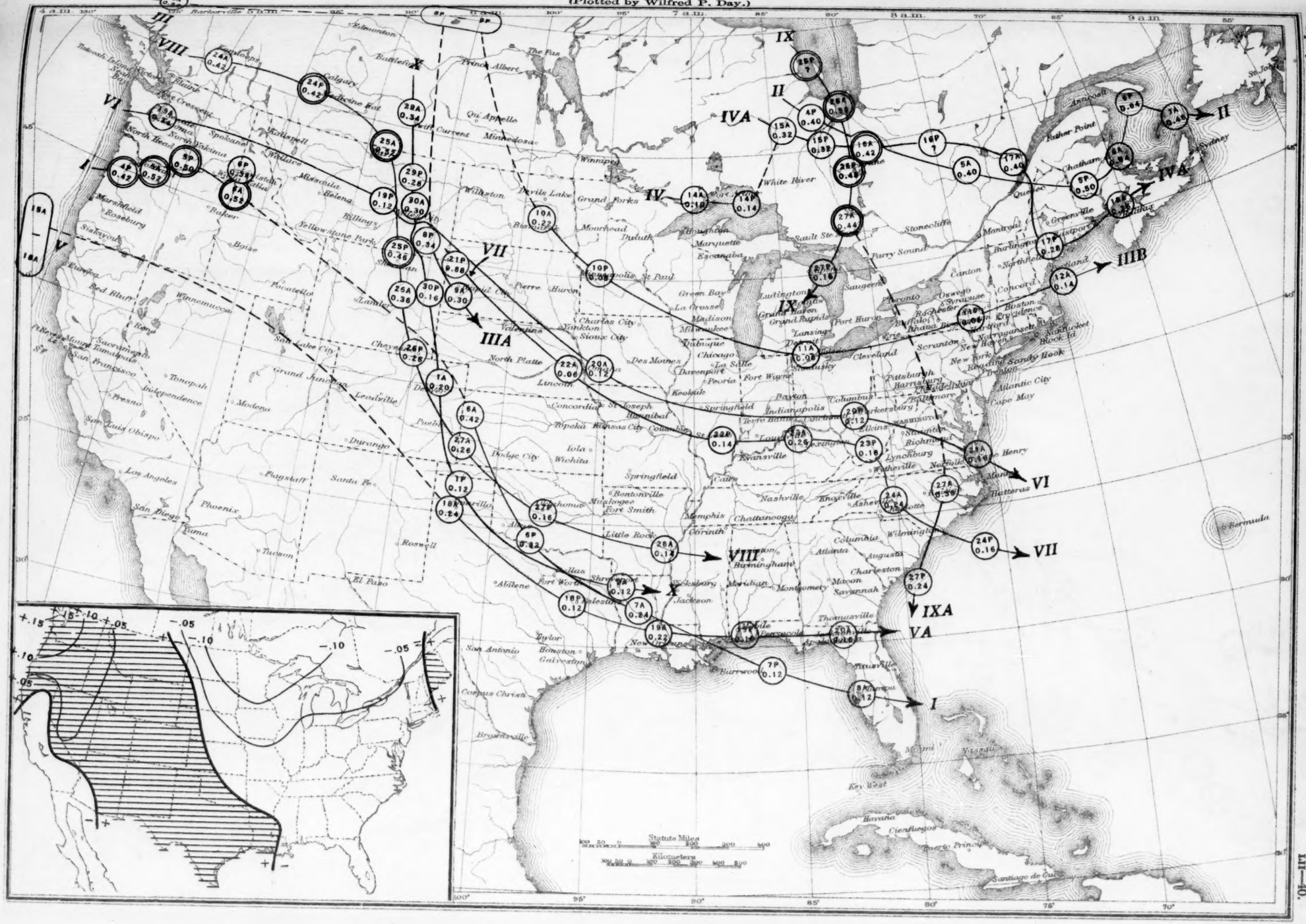

Chart II. Tracks of Centers of Cyclones, April, 1924. (Inset) Change in Mean Pressure from Preceding Month.

(Plotted by Wilfred P. Day.)

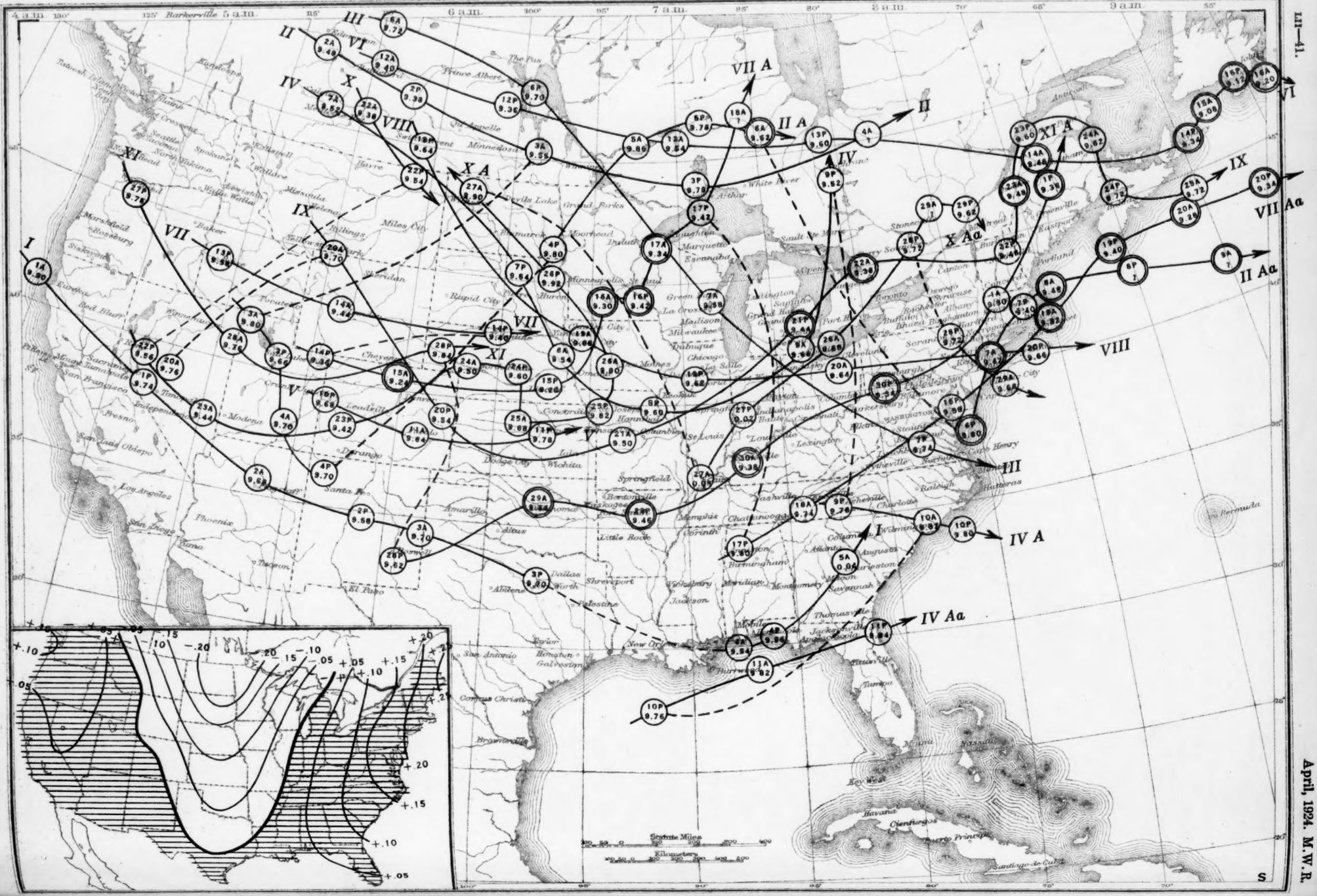

Chart III. Departure (°F.) of the Mean Temperature from the Normal, April, 1924.

Chart III. Departure (° F.) of the Mean Temperature from the Normal, April, 1924.

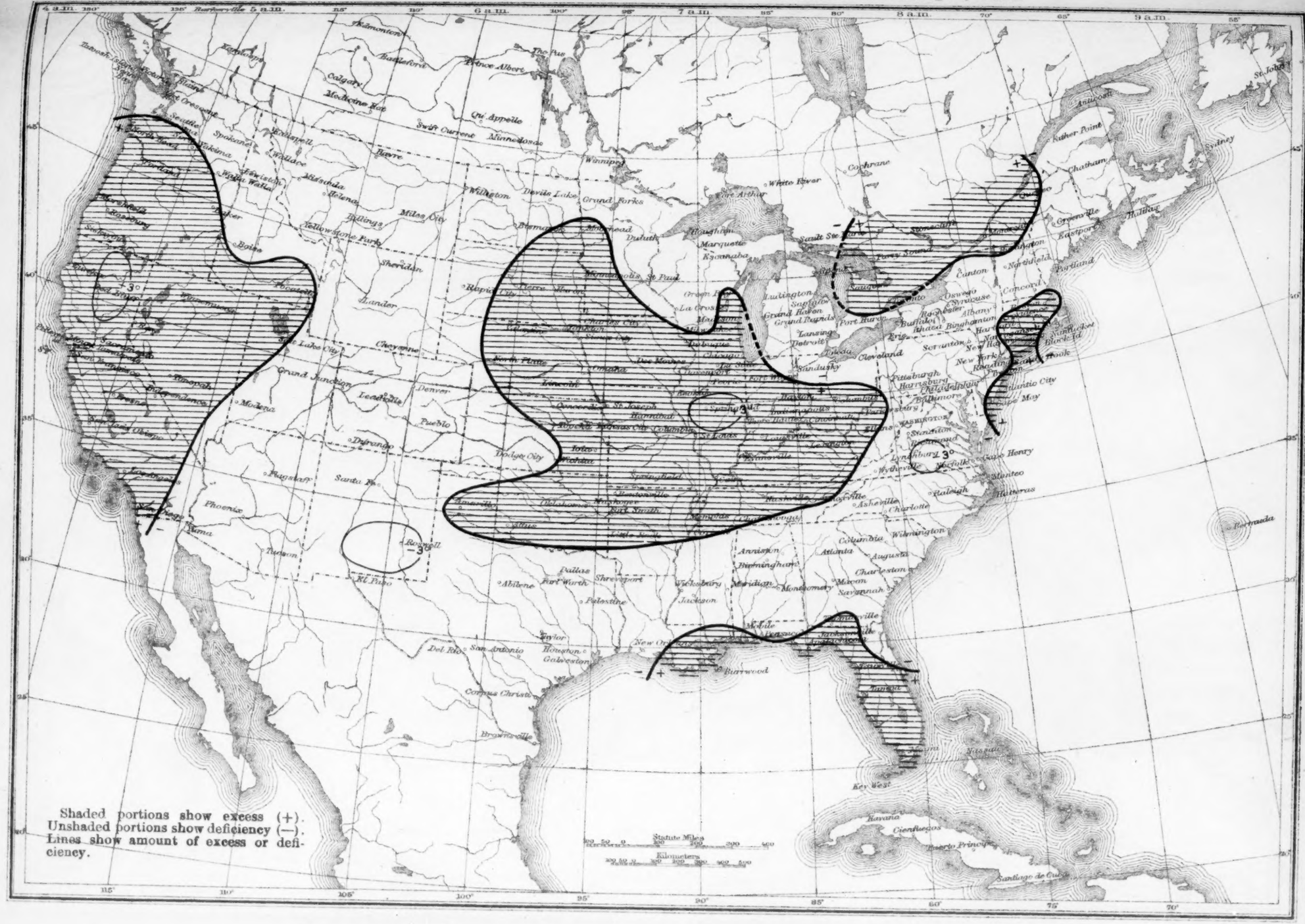

Chart IV. Total Precipitation, Inches, April, 1924. (Inset) Departure of Precipitation from Normal.

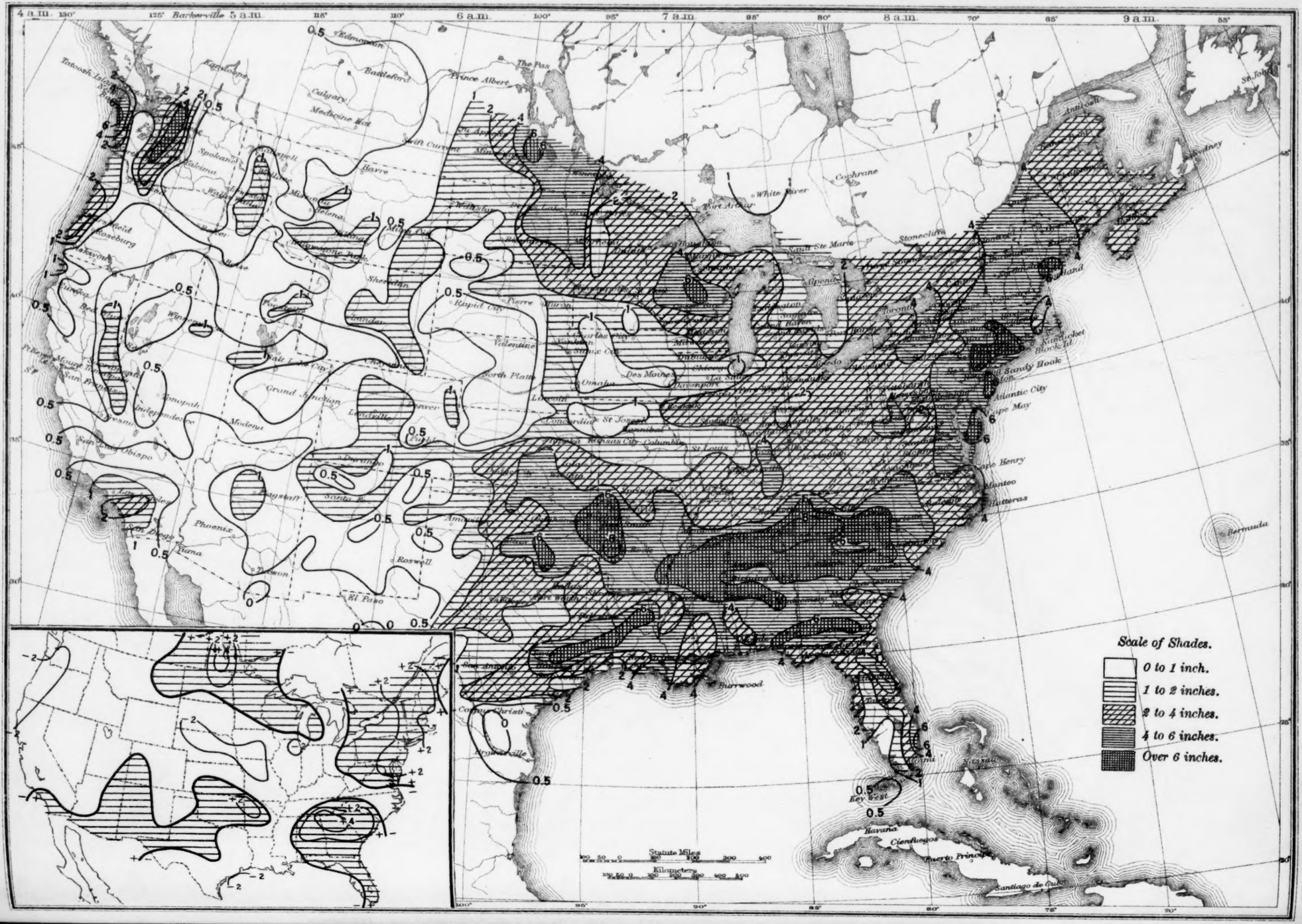

Chart V. Percentage of Clear Sky between Sunrise and Sunset, April, 1924.

Chart V. Percentage of Clear Sky between Sunrise and Sunset, April, 1924.

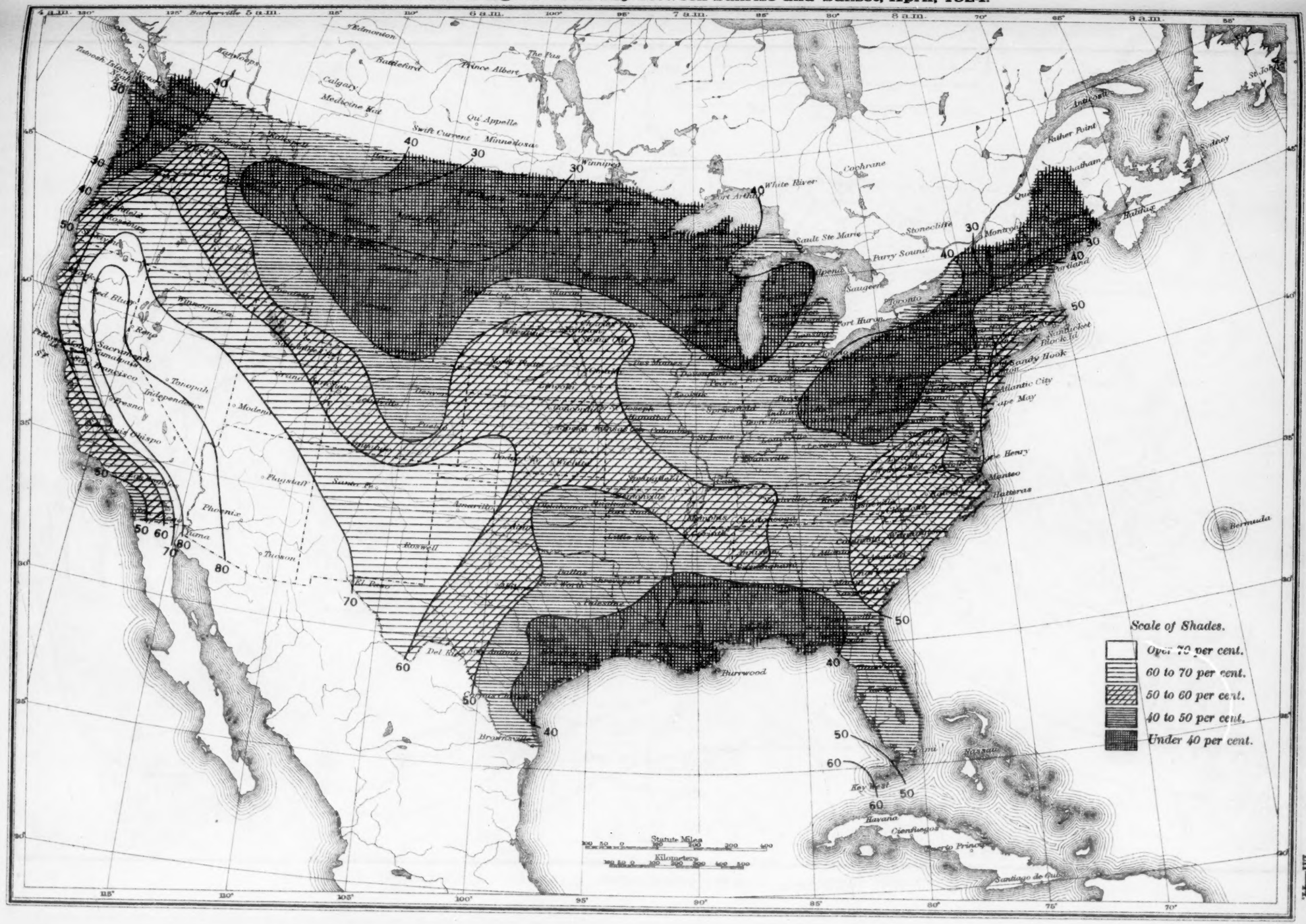

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, April, 1924.

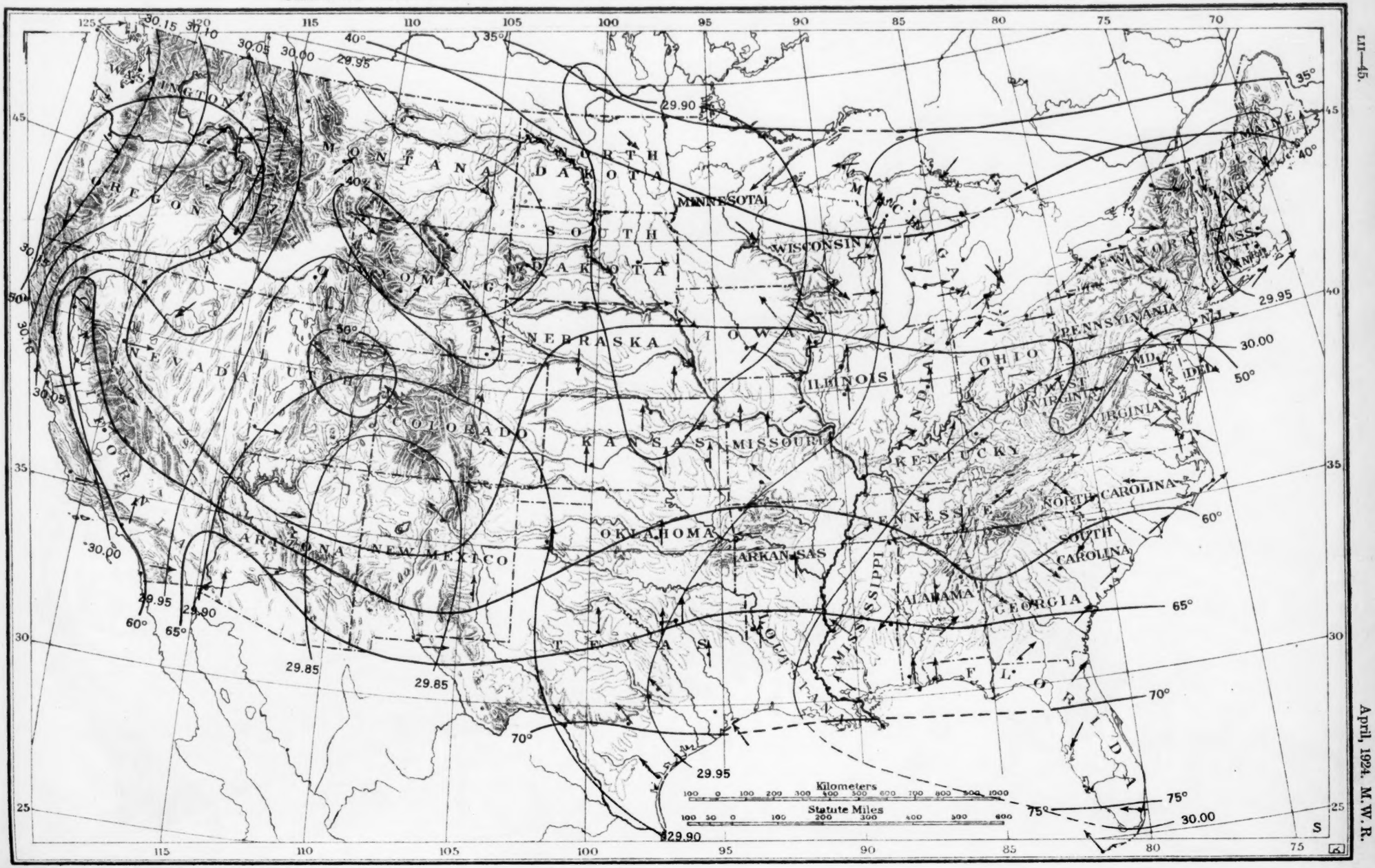

Chart VII. Total Snowfall, Inches, April, 1924.

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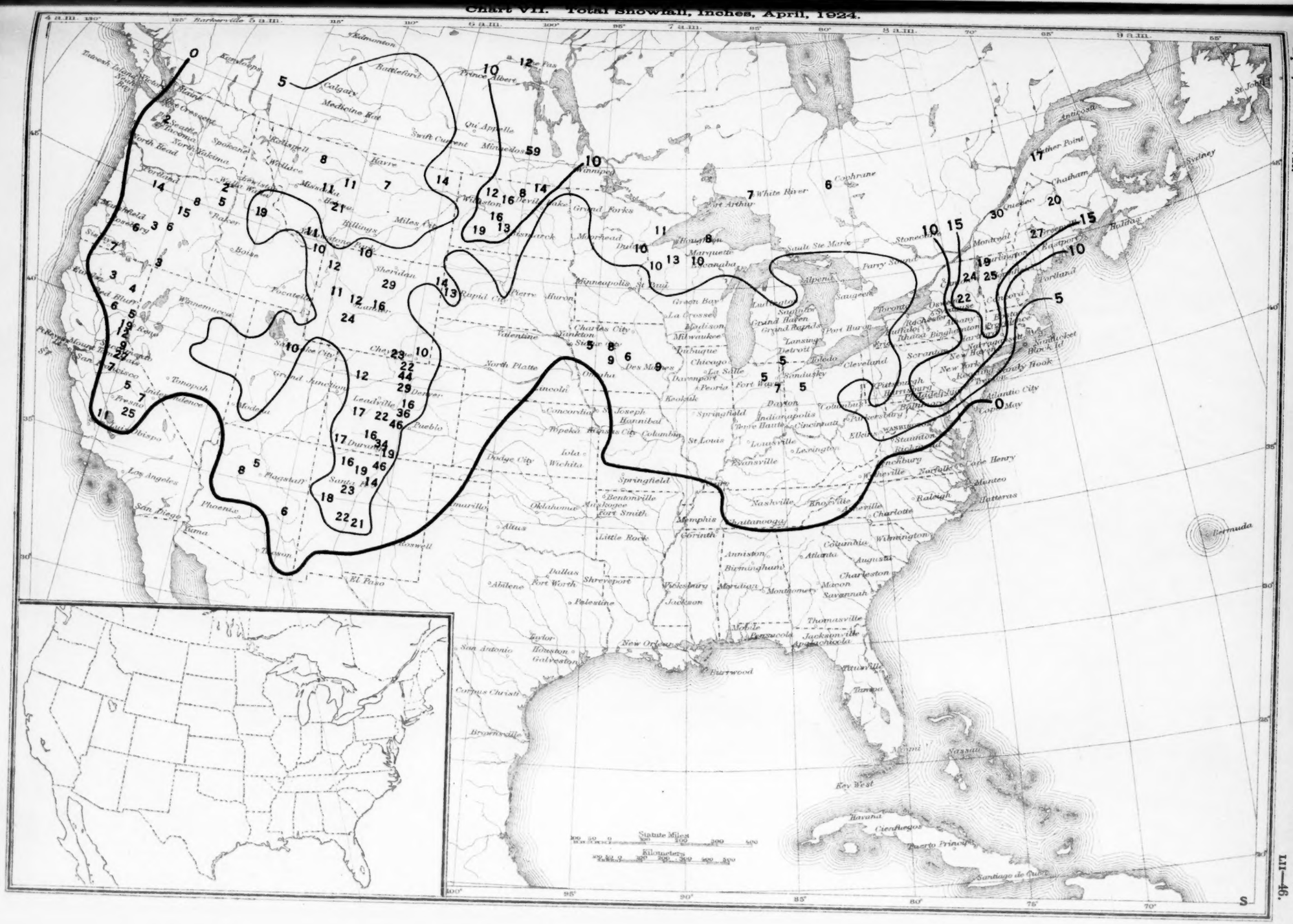


(Plotted by F. A. Young.)

(Plotted by F. A. Young.)

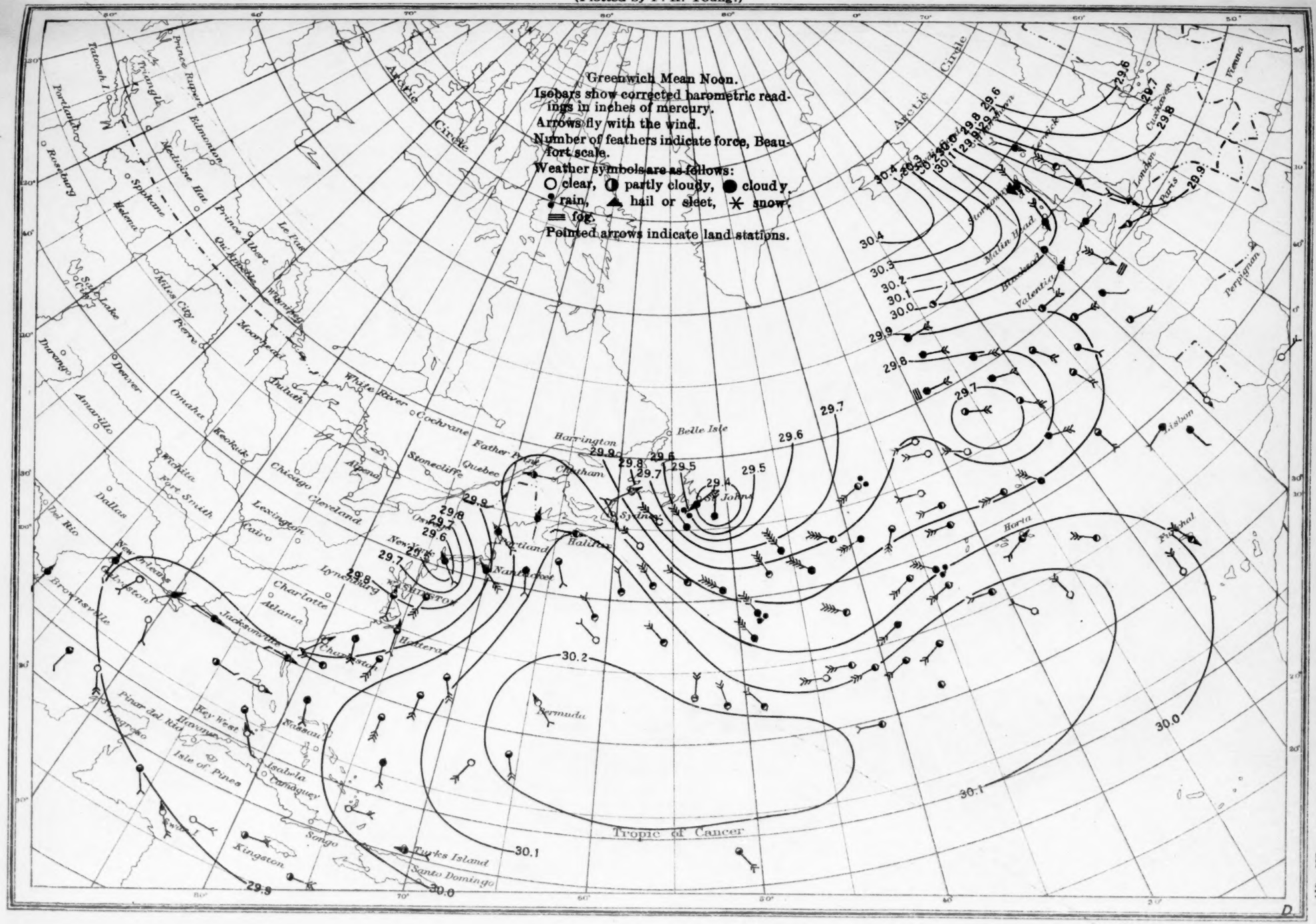
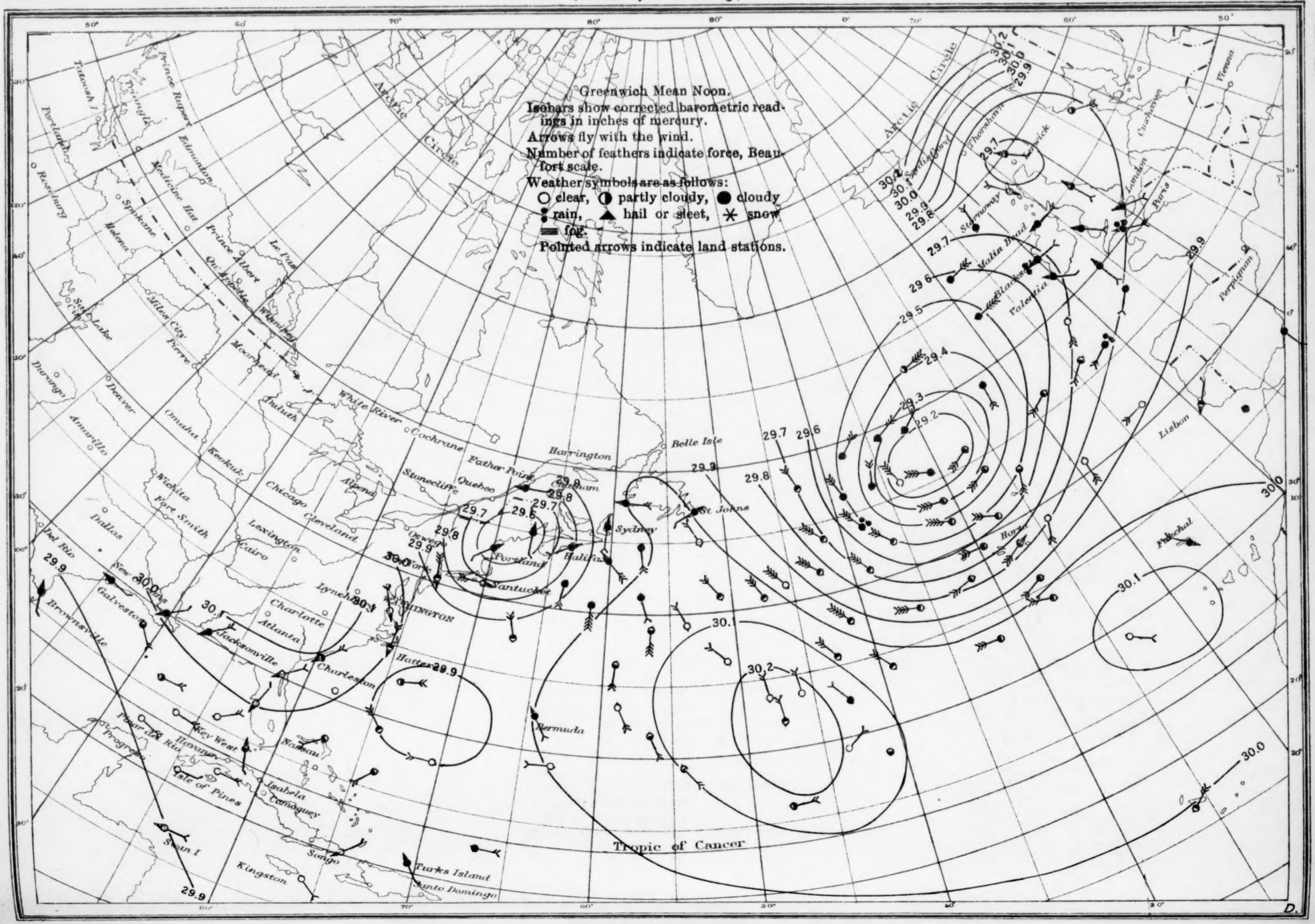


Chart IX. Weather Map of North Atlantic Ocean, April 23, 1924.

(Plotted by F. A. Young.)


Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy
rain, hail or sleet, snow
fog.
Pointed arrows indicate land stations.
Arctic Circle
Arctic Circle
Tropic of Cancer
Prince Rupert
Edmonton
Medicine Hat
Spokane
Helena
Prince Albert
Qu'Appelle
Winnipeg
Moorhead
Duluth
White River
Cochrane
Father Point
Quebec
Stonecliffe
Harrington
Belle Isle
St. Johns
Sydney
Halifax
Portland
Nantucket
Chicago
Cleveland
Omaha
Denver
Amarillo
Dallas
Wichita
Fort Smith
Leavington
Cairo
Charlotte
Atlanta
Jacksonville
Charleston
Hatteras
Galveston
Brownsville
Key West
Havana
Nassau
Isabela
Isle of Pines
Swan I
Kingston
Santo Domingo
Turks Island
Bermuda
Lisbon
Funchal
Perpignan
Paris
London
Valentia
Malin Head
Stornoway
Thorshavn
Lerwick
Archangel
Vienna
Reykjavik
Portland
Medicine Hat
Swift Current
Moose Jaw
Regina
Battleford
Edmonton
Prince Albert
Qu'Appelle
Winnipeg
Le Pas
Moosonee
Duluth
Sault Ste. Marie
Escanaba
Milwaukee
Chicago
Grand Haven
Cleveland
Toledo
Buffalo
Rochester
Albany
Boston
Nantucket
Portland
Eastport
Father Point
Quebec
Harrington
Belle Isle
St. Johns
Sydney
Halifax
Yarmouth
Bermuda
Nassau
Key West
Havana
Isle of Pines
Swan I
Kingston
Santo Domingo
Turks Island
Tampa
Jacksonville
Charleston
Hatteras
Atlanta
Charlotte
Lynchburg
Washington
Pittsburgh
Cleveland
Detroit
Toledo
Chicago
Milwaukee
Escanaba
Sault Ste. Marie
Duluth
Moorhead
Devils Lake
Minot
Williston
Miles City
Havre
Helena
Kalispell
Spokane
Walla Walla
Portland
Roseburg
Tatoosh I
Seattle
Port Angeles
Victoria
Prince Rupert
Triangle
Tatoosh I
Portland
Roseburg
Seattle
Spokane
Helena
Miles City
Pierre
Devils Lake
Moorhead
Duluth
Escanaba
Grand Haven
Milwaukee
Chicago

(Plotted by F. A. Young.)

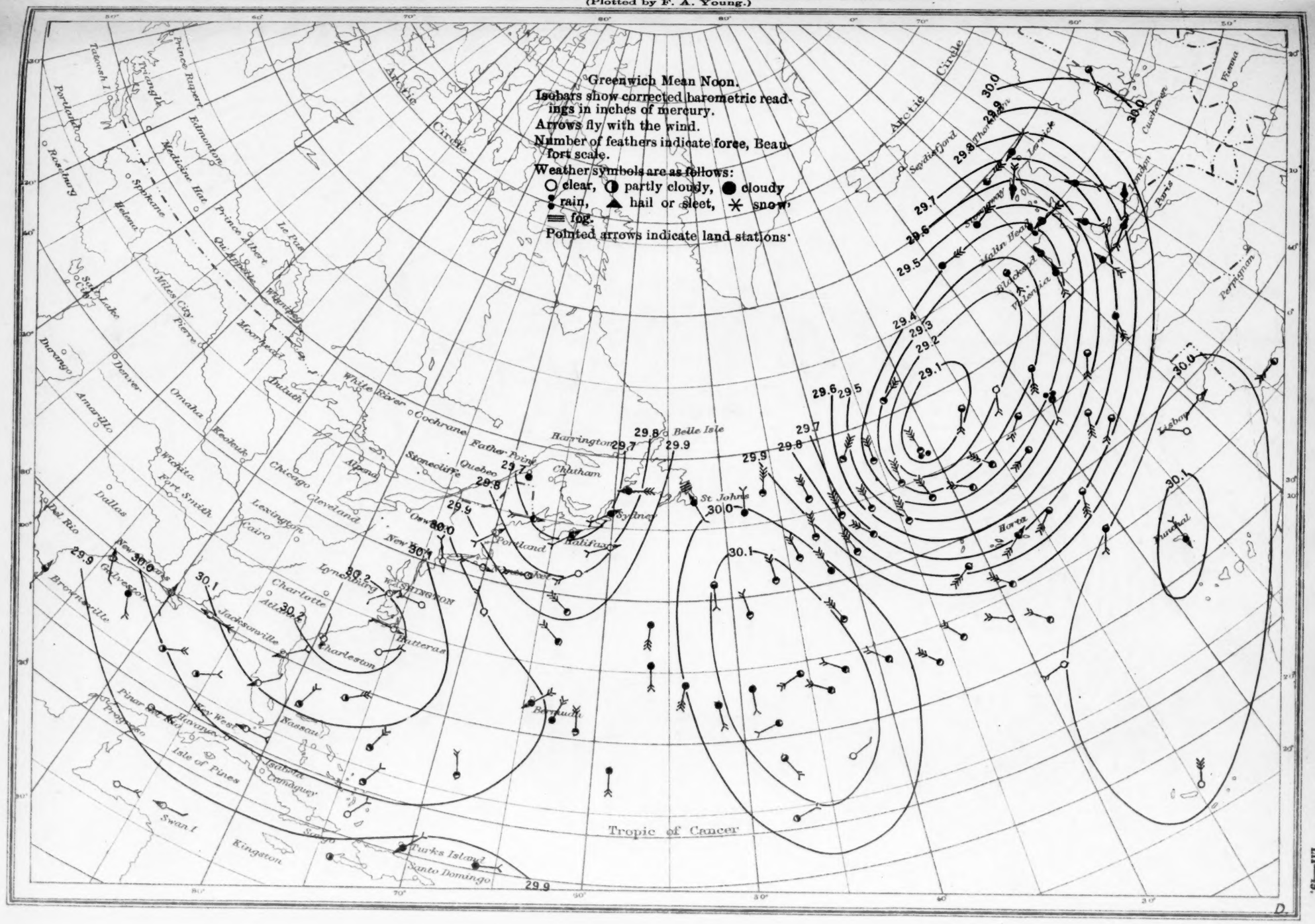
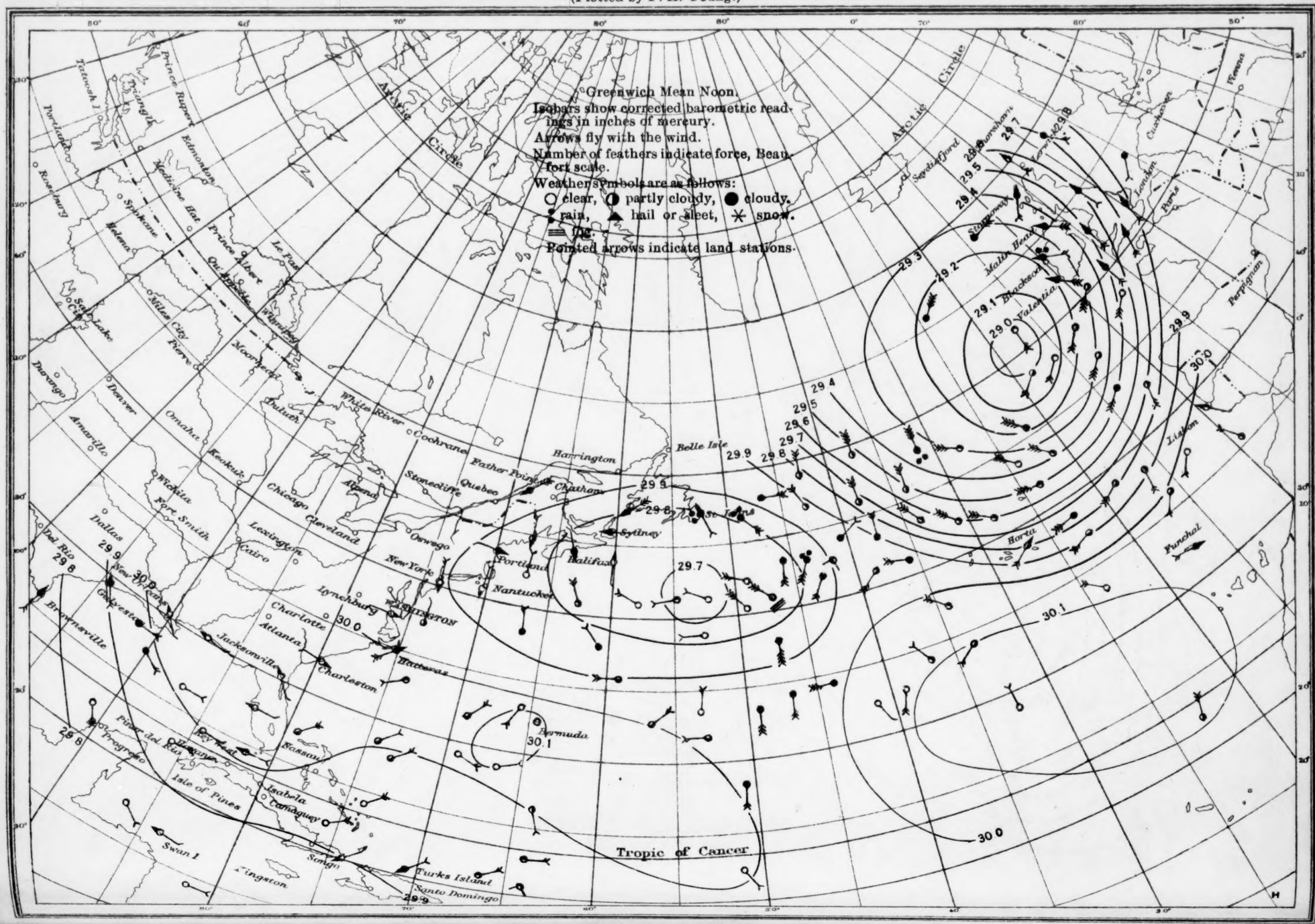


Chart XI. Weather Map of North Atlantic Ocean, April 25, 1924.

(Plotted by F. A. Young.)



(Plotted by F. A. Young.)

(Plotted by F. A. Young.)

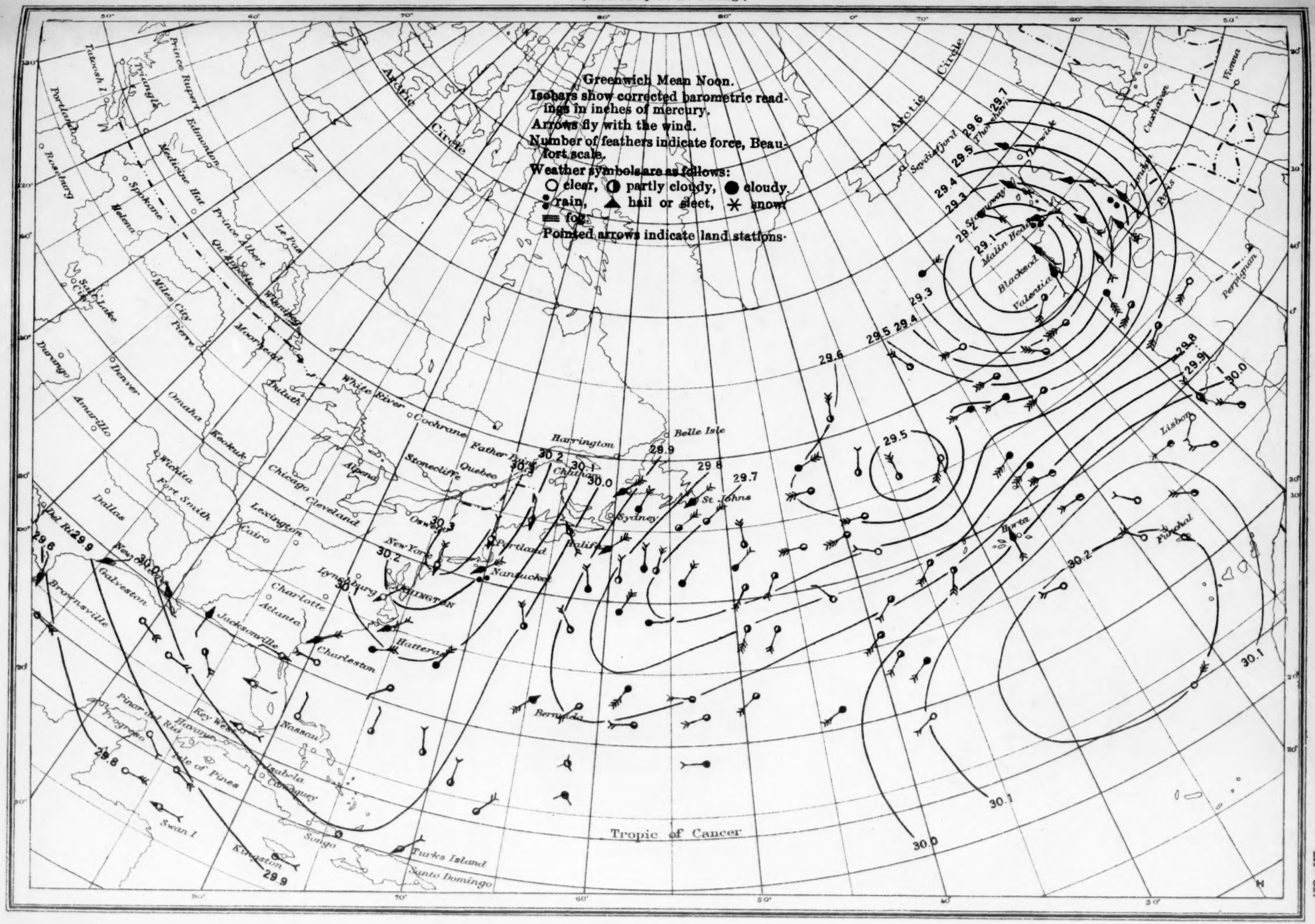
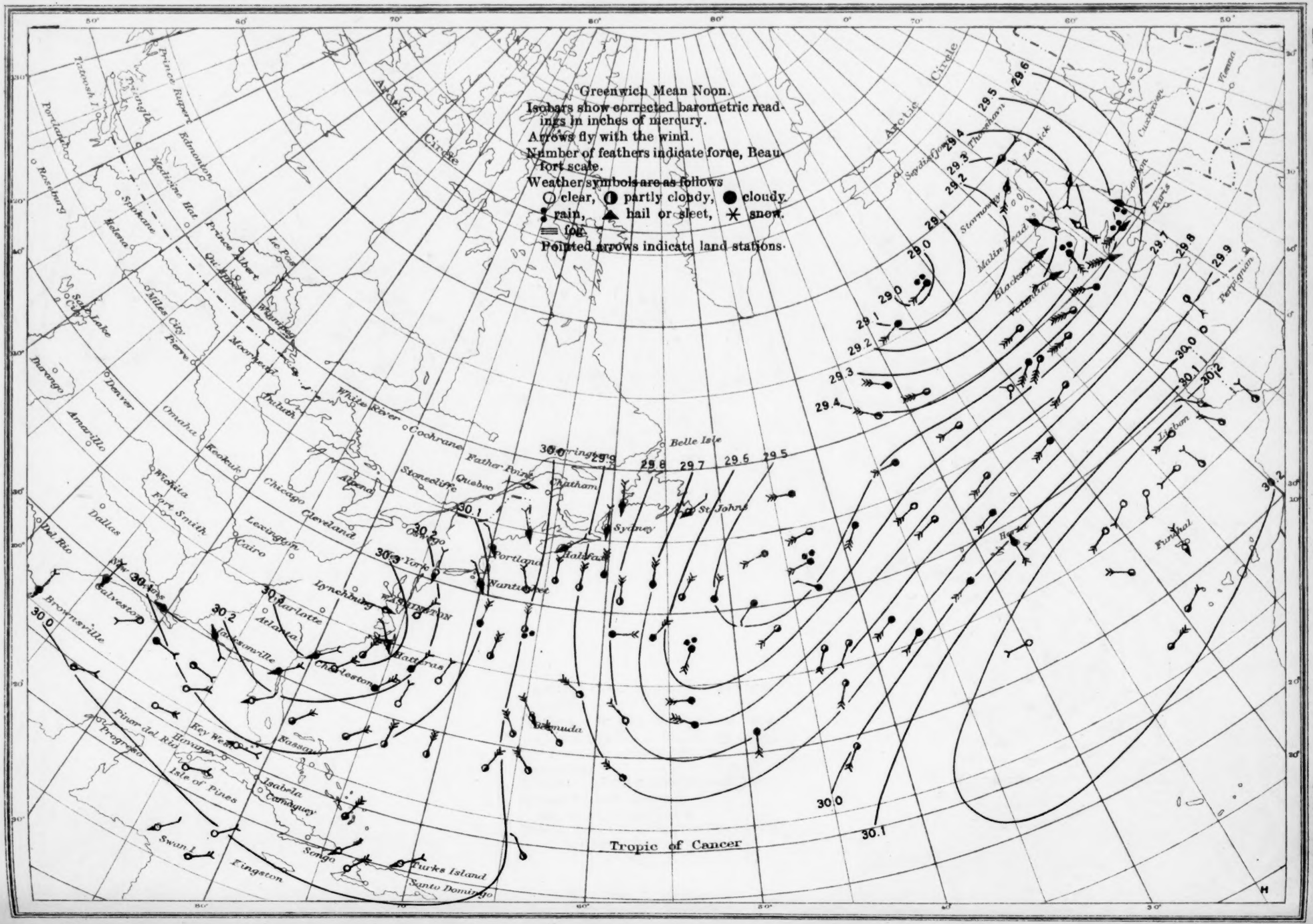


Chart XIII. Weather Map of North Atlantic Ocean, April 27, 1924.

(Plotted by F. A. Young.)